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MARKETABILITY OF RECOVERED AND CLARIFIED INCINERATOR RESIDUE IN THE NEW YORK METROPOLITAN AREA

Leonard S. Wegman Company

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This report presents the results of a preliminary marketing study within an economic distance of the metropolitan New York area (North Hempstead) for the products from a potential plant for incinerator residue separation. A preliminary design and the operating and capital costs for such a plant are also given. Incinerator residue processed through the Bureau of Mines pilot separation plant was analyzed and used for product samples. Marketing investigations of the ferrous, nonferrous, glass, and sand-ash fractions were done with purchase letters of intent being sought. Income from the sale of the products to potential customers was determined as well as any associated transportation costs. The design criteria for the potential 150 TPD plant for North Hempstead are given, and a potential facility, based on the Bureau of Mines process with some modifications, is described in detail. Capital and operating costs for this facility for two- and three-shift operations are tabulated. The savings and other possible benefits from such a resource recovery facility are discussed. The appendix contains a compilation of the marketing contacts and significant replies.

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MARKETABILITY OF RECOVERED AND CLARIFIED INCINERATOR RESIDUE

IN THE NEW YORK METROPOLITAN AREA

This interim report (SW-53d) on work performed
under Federal solid waste management demonstration grant No. G0-EC-00370
to the Town of North Hempstead, N.Y.,
was prepared by

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Since this is an interim report of progress, the conclusions and recommendations should be considered as preliminary in nature, pending final evaluation of findings. These conclusions pertain to the situation in North Hempstead, N.Y., and would not necessarily be directly applicable to other areas in the United States

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CHAPTER 1

INTRODUCTION

1.1 Purpose

This investigation was to determine the marketability in the New York metropolitan area of recovered and clarified residue from the incineration of municipal refuse. The study was sponsored by the Town of North Hempstead, New York whose facilities were utilized.

1.2 Scope

Markets for recovered components of residue, including ferrous and non-ferrous metals, glass and non-organic fines were sought with the intent of obtaining specific outlets for such refined products of a proposed residue recovery plant, located in the Town.

The results of the study provide this information:

(1) The potential quantity and quality of recovered materials from a plant designed to serve North Hempstead.

(2) The costs, including capital, operation and management of a residue recovery and shipping system.

(3) The indicated income from the sale of recovered residue.

(4) Savings resulting from reduced requirements for land for residue disposal and related hauling and spreading costs.

(5) The effect on the environment of having an outlet for incinerator residue.

(6) The projected impact of recovered residue in the metropolitan area if incineration remains a general method for disposal.

(7) The relative marketing prospects of incinerated materials versus non-incinerated materials.

CHAPTER 2

CONCLUSIONS AND RECOMMENDATIONS

2.1 Conclusions

2.1.1 Recovery of incinerator residue at the Town of North Hempstead Roslyn incinerator plant is technically feasible for use as an adjunct to the Roslyn facility.

2.1.2 To handle the residue generated by the Roslyn plant, an incinerator residue recovery facility of 150 tons per 24 hour day, operated two shifts per day, six days per week, would be required. A 20% increase in operation level would satisfy the residue disposal needs for the North Hempstead Denton Avenue incinerator as well.

2.1.3 The estimated cost of a residue recovery plant at Roslyn is $1,400,000. Such a plant will be capable of yielding 25,000 tons of salable components per year.

2.1.4 Amortization and interest on the capital investment for facilities will require $95,000 per year. Operating at 2 shift capacity, 6 days per week, annual operating costs will be $239,000, bringing the total annual cost for the operation at Roslyn to $324,000.

2.1.5 The per ton costs for residue recovery in the proposed plant when operated at 100 tons per 16 hr day would be $10.37 per ton processed. At full rated capacity (150 tpd), the per ton costs drop to $9.21.

2.1.6 Today's general interest among potential receivers contrasts sharply and favorably with that two years ago and presumably reflects the development of new techniques for recycling such materials into new products, together with increasing public demand for resource recovery.

2.1.7 Sufficient markets exist and can be contracted with for the sale of recovered ferrous, non-ferrous, and flint glass.

2.1.8 The average anticipated revenue from all sources, after deduction of transportation costs, is $7.43 per ton of residue processed.

2.1.9 Potential revenue is based on selling ferrous metal at $23.00, aluminum at $200.00, mixed heavy non-ferrous at $100.00, and clear glass at $12.00 to $15.00, all per ton. Operating at 2/3 rated capacity (or 100 tpd), overall annual revenue from the sale and use of the components will be $232,000 after deduction of transportation costs to markets.

2.1.10 For the Roslyn plant the marketing of all the principal salable components of residue will reduce the volume of residue output requiring land for disposal from 65,700 cy to 34,900 cy per year. This will permit a net annual reduction in land consumption of 22 acre-feet.

2.1.11 If the same factor is applied to all the municipal refuse incinerators in the New York metropolitan area within a 50 mile radius of New

York City, the total annual reduction in demand for land volume for residue disposal will be 580 acre-feet. At an assumed fill height of 20 ft per acre, this will indicate a net saving of 29 acres per year in the New York metropolitan area.

2.1.12 The minimum anticipated landfill savings for North Hempstead (based on utilization of nearby sandpits) from the recovery of residue products is $1.24 per ton processed, for land cost alone.

The Town will also conserve the cost of hauling the residue, spreading it and covering it, at $1.50 per cy. The saving from this will be $1.59 per ton processed, and the total landfill savings will be $88,500 annually, at the recommended two shift operation.

2.1.13 The total economic picture considering all costs and all revenues and other savings indicates that a 150 ton per 24 hr day residue recovery plant can achieve a break-even point within estimating limits at 100 tons and a two shift operation. At full operating capacity the economic picture shifts to a positive dollar saving to the Town of over $1.00 per ton processed. The dollar saving, while economically beneficial, does not reflect the intangible saving to the public in terms of reducing land consumption. Such reduction in land consumption obviously leaves land available for public benefit, either for recreational use or as taxable property for residential or commercial development. In land-short communities such as those in the New York metropolitan area, this intangible factor may prove to be the most important element.

2.2 Recommendations

2.2.1 A 150 ton per 24 hr day demonstration incinerator residue recovery plant should be built at the Roslyn Harbor incinerator. This facility will be the first full-scale residue recovery plant. The benefits will accrue in public economy, reduction of land demand, conservation of natural resources and the efficient handling of solid waste. Such a full-scale recovery plant will be a useful model for government, industry and the entire country.

2.2.2 The residue from both North Hempstead incinerators should be processed in this facility. In addition, commitments to receive at least 20 tons per day, six days per week, from a plant outside the Town should be made in order to operate the plant at full capacity.

2.2.3 Contracts with potential users of the recovered products should be arranged, including such industries as:

Ferrous Metal	National Steel
Non-ferrous Metal	Reynolds Aluminum J.R. Elkins, Inc.
Clear Glass Cullet	Metro Container Owens-Illinois Thatcher Glass

Transportation	Long Island Railroad Contract trucker
Rail Siding Use	Helena Rubenstein

2.2.4 Funds for the design, construction, operation and evaluation of the demonstration residue recovery plant should be sought from the Federal Environmental Protection Agency and the State of New York.

CHAPTER 3

SOLID WASTE MANAGEMENT IN NORTH HEMPSTEAD, NEW YORK

3.1 Initial Solid Waste Handling

The Town of North Hempstead has a population of 237,000 and lies in the northwestern sector of Nassau County, Long Island, New York. The western edge of the Town abuts the Borough of Queens in New York City.

The Town has a history of attention to solid waste management. After the Town's disposal needs were served by a number of landfill sites, including Flushing Meadows, for many years, a private enterprise headed by the grandfather of the present superintendent of the Denton Avenue disposal plant constructed and began operating the original plant at Denton Avenue in 1931. The plant had a capacity of 175 tpd and burned garbage from North Hempstead and a portion of the Town of Hempstead. It also accepted rubbish, bulk, and garden waste from its garbage-disposing customers for direct disposal along with residue at the adjacent landfill. Several other landfills under other management existed in the locality at that time, but legislation designed to protect the investment in the incinerator prevented export of waste over the City line to such fills as Flushing Meadow. Today, an even more restrictive situation exists for the opposite reason. In many areas, garbage is restricted from even crossing Town lines, because the localities do not want waste imported.

Of interest also is the recycling activity at the first incinerator plant, where an estimated 15 to 20% of waste was salvaged, including papers, cardboard, fats and incinerated cans. There were no dumping pits, and men removed items for salvage from the floor, where the garbage was dumped prior to being bulldozed into the furnace. Working from both sides of a conveyor leading to the furnace, men removed bottles, paper, cardboard, fats and other items. As scrap prices dropped and labor costs grew this procedure was not continued when the new Denton Avenue plant began operation.

The Town established firm control over solid waste management by purchasing the old plant as the price of private waste disposal contracts increased to $2.50 per ton. Five years later, in 1953, the present Denton Avenue plant opened under Town operation.

3.2 Present Solid Waste Disposal Practice

Disposal facilities in the Town presently comprise two incinerators, the Denton Avenue plant in New Hyde Park designed in 1952 with a dependable monthly capacity of 4,900 tons[1], and the plant at Hempstead Harbor in Roslyn designed in 1962 with a dependable monthly capacity of 13,100 tons.[2] Residue generated at the two plants is deposited in the landfills adjacent to each.

---

[1] Limited storage facilities and five-day week operation reduce present burn rate.

[2] Actual burn rate is 13,500 tons per month.

When tested in 1967, the Hempstead Harbor plant emissions were 75 to 80% below the current 1970 New York State air pollution requirements. The Denton Avenue plant was tested in 1971 after having been upgraded to meet new control requirements, and was found to better current New York State standards by 31 to 57%.

Administration of the two solid waste disposal facilities is unified under the office of Supervisor of Incinerators, created when the Hempstead Harbor plant was built. The superintendent at each disposal plant is directly responsible to the Supervisor of Incinerators, who, in turn, is under the direction of the Commissioner of Public Works.

3.3 Further Development of Solid Waste Management Policy

A Study of solid wastes for the Town completed in June 1970[1] predicted that the estimated peak refuse per month would rise from 24,800 tons in 1970 to 44,400 tons in 1990. Table 1 shows the prediction of the estimated peak refuse per month at five year intervals from 1970 to 1990.

Table 1 - Estimated Peak Refuse Per Month

Year	Tons
1970	24,800
1975	28,100
1980	31,800
1985	37,400
1990	44,400

The per capita refuse production in the Town is steadily increasing, while the capacity of existing facilities to handle this refuse is gradually decreasing due to increasing heat value per pound of refuse. Unless significant steps are taken, the situation may deteriorate to the point where the Town suffers critical environmental damage.

A new disposal facility, a 900 ton per day capacity incinerator, has been recommended for the Town.[2] However, because some environmental groups oppose incineration, ostensibly because of air pollution considerations, construction of this facility has been delayed.

New York State and Nassau County performed a comprehensive survey of solid waste disposal needs in Nassau County in 1970-71, conducted by the engineering firm of Teetor-Dobbins. The report stated that, "Only one proven treatment and disposal method is suitable for overcoming the present deficiencies [in Nassau County] of existing disposal facilities -- the incineration of all combustible refuse and the utilization of the resulting high quality residue in incombustible refuse as clean-fill." The report further states, "successful completion of the recommended program will eliminate the present practice of sanitary landfilling which is not considered a suitable disposal method for Nassau County because of the ever-present danger of contaminating the pervious ground water supply and polluting the adjacent surface waters." The proposed 900 ton per day capacity incinerator is recommended in the Teetor-Dobbins report.[1]

---

[1] Leonard S. Wegman Co. Inc., Engineers, Study of Solid Wastes, Town of North Hempstead, June 1970, p. 2.

[2] Ibid, pps. 3ff.

An exhaustive study of all disposal alternatives was made by Leonard S. Wegman Co. Inc. in conjunction with the study of solid wastes for the Town in 1970 and was reviewed in October 1971.[2] The only present economically feasible alternatives within the political control of the Town are incineration processes. The high cost of land in the Town precludes any form of disposal which does not achieve a significant degree of volume reduction. Removal of the refuse to a site remote from the Town has been considered, but is not a practical solution at present because no other area has consented to receive the Town's wastes.

Residue from the incinerator is placed in landfills adjacent to the incinerator plants. At present, additional land is unavailable for landfill, except via condemnation. To create a site for residue disposal in accordance with the long term solid waste disposal plan developed by the Town in 1962, application was made in August 1970 to the U.S. Army, Corps of Engineers, for a permit to extend the existing harbor embankment, adjacent to the Roslyn plant, for receiving incinerator residue. Although this project is essential to the Town's program, its implementation has been delayed by objectors to the use of wetlands. The completion of the plan now depends on a permit, the processing of which must conform with the new Federal regulations and executive orders effective in 1970 and related administrative procedures of the Corps of Engineers. This delay aggravates the unavailability to the Town of land for incinerator residue disposal.

3.4 Residue Recovery

In March 1971, the Town applied to the Solid Waste Management Office, Environmental Protection Agency, for a grant to study the marketability of recovered and clarified incinerator residue in the New York Metropolitan area. This application matured into the project for which this is the final report. The Town's primary incentive in pursuing a course involving exploring the problems and potentials of recovering incinerator residue and acting as a pilot community in this venture, lies in the Town's desire to reduce to a minimum its need for additional land. The following sections describe the investigation.

---

[1] Teetor-Dobbins, An Action Plan of Solid Waste Management for Nassau County, N.Y., April 1971, pp. IX-18, IX-29.

[2] Town of North Hempstead, Environmental Impact Statement, Supplementary Information with Conditions as of October 1971. Submitted to U.S. Army Corps of Engineers on behalf of the Town of North Hempstead by Leonard S. Wegman Co., Inc.

CHAPTER 4

REFUSE AND RESIDUE TESTS

4.1 Conditions Required for Tests

The refuse and residue tests were provided as a check on the conditions experienced for the days during which residue was taken to provide the Bureau of Mines the raw material needed for the processing at their pilot plant in College Park, Maryland.[1]

The Environmental Protection Agency, after examination of the Roslyn incinerator facility, concurred with the decision to run at least two tests: one using the traveling grate furnace at the rated capacity of 200 tpd and one using the rocking grate furnace at 110% of rated capacity.

These conditions presented an extreme test of the Roslyn facility since the practical capacity of each furnace on an annual basis is 1400 tons per week times .85 for routine maintenance times 6/7 for normal operating availability due to extraordinary maintenance and shutdowns. This indicates a capacity of 1020 tons per week per furnace on an annual basis.

4.2 Refuse Receiving Method

A representative day's sample of raw refuse was needed as a reference. Each truckload of solid waste for the sample arriving at the Roslyn incinerator on October 19, 1971 was recorded at the scale house for weights and volumes. The trucks unloaded into the north refuse receiving bin whose water level capacity is about 600 tons. The pit was emptied prior to the test, so that the needed 200 tons would be all that was available for the incinerator run, this equaled 24 hours supply for one furnace.

Waste was largely residential (75%) with occasional loads of commercial refuse (25%), typical of Roslyn receipts.

The data as recorded by the scale attendant is presented in Appendix C.

4.3 Refuse Sampling Procedure

Sampling procedures had to be established, due to lack of established guidelines. Review of available literature and discussions with several federal agencies confirmed that procedures and techniques for sampling refuse and residue are in the developmental stage. The Office of Solid Waste Management Programs made their sampling procedures available as a guide, and U.S. Bureau of Mines provided technical assistance and guidance.

---

[1] Flow Diagram, Appendix C

4.3.1 Sampling Purpose

Samples of incoming raw waste were taken to determine characteristics, particularly density and physical composition.

4.3.2 Preparation of Representative Sample

It is difficult to obtain a representative sample from a given quantity of refuse because of its heterogenous nature. To make the sample as typical as possible of the incoming waste, the following sequence was devised.

The crane operator on the morning shift mixed the refuse in the pit, and took samples at different pit depths and locations, placing them at one end of the pit.

When eight bucketloads of refuse were piled in the working area, the crane operator mixed them intensively. Finally a bucketload was taken from the pile for use as the sample in the density and composition determinations.

Figure 4-1 shows the locations and depths from which buckets of refuse were selected for the sampling mix.

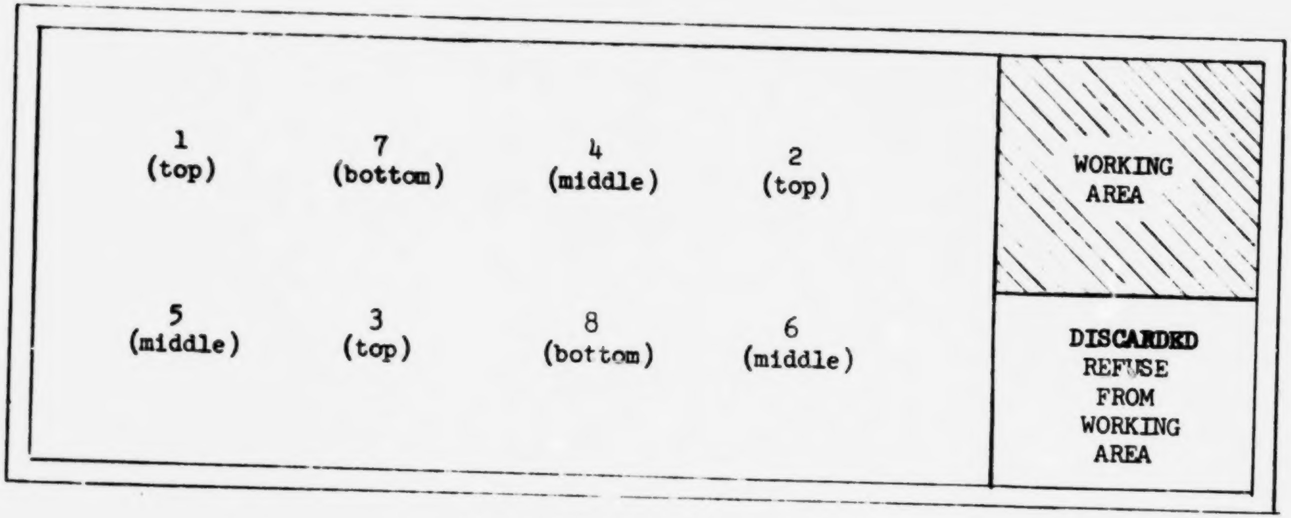
4.3.3 Equipment and Supplies

The following equipment and supplies were used for the sampling:

55-gal open head steel drums
30-gal steel drums with clamp top covers
Plastic sheets (10 ft wide - approx. 1,000 sq ft)
Plastic bags - heavy weight (55 gal & 30 gal)
Shovels
Portable scale - 1000 lb capacity
Utility hand truck
Front end loader
Truck to transport drums
Dump trucks to receive residue (two)
1" mesh screen (2 ft x 2 ft)
Push brooms
Fish net (cheese cloth)
Small magnets
Gloves
Cord, tags, clipboards, marking pens, spray paint
Hand shears, putty knife, hammer, saw and handling tools

The space underneath the crane parking area served for refuse sorting. The concrete surface was cleaned before starting. The refuse was then withdrawn from the working area in the north bin and discharged via the south trap door into the area underneath the crane parking space, for sorting and separation.

REFUSE SAMPLING DIAGRAM


1
(top)
7
(bottom)
4
(middle)
2
(top)
WORKING
AREA
5
(middle)
3
(top)
8
(bottom)
6
(middle)
DISCARDED
REFUSE
FROM
WORKING
AREA

PLAN OF REFUSE PIT

Buckets 1,2 & 3 from top of refuse to working area
" 4,5 & 6 " middle of " " " "
" 7 & 8 " bottom " " " " " ^

First sample was taken from the top of the pile in the working area following mixing. Any additional samples were taken from the center of the working area.

FIGURE 4-1

4.3.4 Density Measurements

The representative bucketload of refuse was placed in the separation area. Two plant laborers shoveled the refuse into the 55-gallon drums. Loading of these drums was done in a manner which avoided having the material too loose or too tight in the container.

As a drum was filled it was taken to the portable scale and the total weight of container and waste recorded on the "Incoming Solid Waste Density Determination Field Data and Calculations" data sheet. The drum was then dumped in the area set aside for composition determination and the empty drum returned to the first area. The data derived is in Appendix C.

4.3.5 Composition Measurements

These categories are consistent with EPA procedures and were used for the composition analysis:

1. Food Waste
2. Garden Waste
3. Newsprint
4. Corrugated Boxboard
5. All Other Paper
6. Plastics
7. Rubber and Leather
8. Textiles
9. Wood
10. Fines
11. Ferrous Metal
12. Non-ferrous Metal
13. Glass
14. Ceramics
15. Ash, Dirt, Rocks

Barrels previously labeled with the categories above were placed in the sorting area. Three workers hand-picked the material for separation.

Unidentifiable material remaining after separation was placed in the fines category. Following sorting, each drum was weighed and recorded, data in Appendix C.

Sorting was repeated in the afternoon of the same day, using another sample from the working area in the pit, as a check for consistency.

4.3.6 Laboratory Sample

From each classification, a proportionate sample was taken to constitute a composite sample which would be typical of the original refuse composition. The two categories of combustile and noncombustible were placed in separate plastic bags and taken to a laboratory for analysis. Analysis results are in Appendix C.

4.4 Residue Sampling Procedure

4.4.1 Purpose

Since residue is a complex wet mixture of metals, glass, dirt, stones, organic materials and ash, and because different incinerators use different methods of discharging the residue, the procedure used to obtain the residue samples is of the utmost importance.

At some incinerators it is possible to sample directly from the discharge chute. This method is considered superior because it does not involve manual handling of the residues and rules out any selectivity of sample.

The physical layout of the discharge system at Roslyn made it very difficult to sample residue directly from the chute. Therefore, an alternate method was used to obtain the samples for Test No. 1 which involved truck collection and then sampling.

The same procedures were employed for all tests except as noted in this report.

4.4.2 First Test

For the first test the furnace (Furnace No. 1) a traveling grate type - was run at the rated capacity of 200 tpd. To empty the pit at a uniform rate, it was estimated that 16,700 lbs per hour would have to be charged to the furnace. From the refuse sampling test it was determined that the average weight of a bucket was 1,000 lbs. Therefore, if an average of 16.6 bucketloads of refuse per hour were charged into the furnace, the pit would be emptied at the end of 24 hours, and the furnace would be run at rated capacity.

At 12:00 A.M. the crane operator started charging Furnace No. 1 with refuse from the north pit. All crane operators were instructed to charge at a rate of 17 buckets per hour, until the refuse in the north pit had been exhausted.

Each bucket of refuse charged into the furnace was recorded on the "Refuse Charges into Furnace" data sheet (Appendix C). The charges made during each hour were recorded. This procedure was done for the entire 24 hours.

The north tipping floor was swept and washed in order to clean the area where the residue sampling was to be conducted. The 30-gallon drums were lined up on the side of the building along with the drum lids, plastic bags and tools for easy accessibility during the residue sampling.

The truck to be used for collecting the residue was cleaned and the tare weight recorded. The truck was then located inside the ash tunnel where it collected residue from Furnace No. 1 for two hours.

The truck driver was instructed to deliver the load of residue to the scale house to be weighed. Each truckload of quenched residue was allowed to drain. As the truck was being weighed, the man recording the data estimated the fill of the truck. After weighing, the residue was dumped on the tipping floor area. Excess water was allowed to drain before the "quartering" process began.

Using a front-end loader, one-half of the pile was removed and returned to the truck. The front-end loader then spread the remainder of the pile into a rough circle taking care to mix and turn over the residue. Half of this mixture was removed and also put into the truck.

Three workers then shoveled the remainder of residue into 30-gallon drums until eight drums were filled. As a drum was filled, its weight was recorded on the "Residue Field Sample Shipped" data sheet (Appendix C).

The drums filled with residue were allowed to cool before the lids were put on. Because of the odoriferous nature of the material and the safety aspects involved, samples were put in 30-gallon drums having airtight quick-lock lids and lined with a heavy duty polyethylene. The drums for which tare weights were recorded, were then put inside the truck for hauling to the Bureau of Mines, College Park Metallurgy Research Center in Maryland.

4.4.3 Second Test

No refuse sampling was conducted during the second test as it was not felt necessary by the Environmental Protection Agency following a review of the results obtained for the refuse sampling of the first test.

Other changes included the use of a rocker type furnace, the south pit rather than the north for storage of the refuse, the furnace charge equaled 220 tons in 24 hours or 110% of rated capacity, and the method of residue sampling was altered to fit new Bureau of Mines requirements.

These requirements were:

> Remove only 1/2 to 1 cubic yard from the furnace for each sample. Fill thirty 30-gallon drums. Ship all of the residue discharged (1/2 to 1 cubic yard) for each sample, less the massive metals. Record weights and descriptions of all massive metals taken out of sample.

It was known from the first test results that there was a 50% weight reduction (wet basis) through the furnace. The residue was estimated to have a density of 50 lbs per cubic foot or 1350 lbs per cubic yard.

For this second test there would be an input of 220 tons, therefore 110 tons of residue would result. The hourly rate of discharge for 24 hours would be 4.6 tons per hour, or 153 lbs per minute. Inasmuch as 0.113 cubic yards per minute would be generated, a period of 8 to 9 minutes would be needed to get the required 1/2 to 1 cubic yard per sample. Each sample would fill approximately six 30-gallon drums; therefore a total of five samples would be required. These would be spaced over roughly 8 hours.

However, if any corrections were needed after the first sample was taken, the remaining sample would be adjusted to these requirements judging from the first sample. This flexibility was required due to the uncertainty of attempting to accumulate a 1/2 to 1 cubic yard sample in 9 minutes. This procedure was, at best, trial and error.

For the second test, a rocking grate type furnace - Furnace No. 3 - was to be run at 110% rated capacity, which is 220 tons per day.

In view of the time differential of 1-1/2 months between the two tests, a check was made on the weight of refuse per bucketload to determine if any density change had occurred.

The refuse to be burned for Test No. 2 was thoroughly mixed before a sample was taken. The bucket of refuse was taken to the crane overhang and emptied into a dump truck. This truck was taken to the scale and weighed. The weight of the refuse was computed by subtracting the tare weight of the truck from the total weight of truck and the refuse. This procedure was repeated several times and it was found that the average weight per bucket was 1200 lbs.

It was then calculated that if each bucketload weighed 1200 lbs and 220 tons were to be emptied in 24 hours it would take an average charge of 15.25 bucketloads of refuse per hour to burn 220 tons in 24 hours. The plant personnel and crane operators were so instructed.

As loaded trucks arrived at the Roslyn incinerator direct from their routes, they were weighed at the scale house where the scale attendant recorded the necessary data. The truck was then directed to empty into the south refuse pit, which had been completely emptied and cleaned. This procedure was followed until 110 tons had been collected.

In order to get a more representative sample of refuse, only half of the required 220 tons was accumulated in one day. The remaining half was accumulated the following day.

There was no selecting of the trucks. All trucks were taken, except trucks hauling bulk items or trees and brush, which are not normally processed through the incinerator. The south pit was then isolated from receiving more refuse after 220 tons had been accumulated.

Preparations were made to have the sampling area ready for the tests. The south tipping floor was swept and washed. The 30-gallon drums were cleaned and lined up around the test site. Equipment that would be used was made available.

At the designated time a residue truck emptied the ash hopper of Furnace No. 3. A second residue truck would then move into position under the ash hopper. After ten minutes all of the residue accumulated was dumped into the truck. The truck then proceeded to the south tipping floor for dumping the residue. The residue was drained of excess water before dumping.

After the residue was dumped and allowed to cool it was shoveled into 30-gallon drums. All residue was placed into the drums.

Massive items which were too large to be processed in the Bureau of Mines system were placed aside until the residue sampling was completed. They were then weighed and written records prepared for the Bureau of Mines.

4.5 Residue Processing and Testing

4.5.1 Purpose

The purpose of the residue processing and testing was to generate clarified products for use in marketing analysis and to determine the quantities and characteristics of such products for sizing of a residue recovery facility for North Hempstead. All processing and testing of residue was conducted by the Bureau of Mines.

4.5.2 First Test

Before the residue was processed, the Bureau of Mines pilot plant[1] was operated without residue so that the system could be rinsed and cleared of any residue material from the previous run. On Oct. 21, 1971, at 8:30 A.M., the pilot plant began processing 25 randomly selected drums of residue, they were placed next to the metal receiving apron at the head of the plant. A hoist was used to empty the residue from the drums. Following removal of the residue, the tare weight of each 30-gallon drum and lid was recorded. The remaining drums were processed the following day.

Receiving Apron and Conveyor

The contents of the drums were dumped into the receiving apron with the aid of a hoist. A Bureau of Mines employee was assigned to rake the residue from the receiving apron onto the flight conveyor. This conveyor fed the material into the trommel, described below.

Another employee was stationed on the other side of the receiving apron to manually remove any material such as grass, organics and bulk metals, which could not be processed in the small pilot plant. These items were placed separately into labeled containers.

This procedure was necessary primarily due to the limited processing capability of the pilot plant. Large items and organics tend to clog the small pieces of equipment. A full scale plant would not have this difficulty.

It was noted that the flights on the feed conveyor did not span the entire width of the conveyor trough, thus allowing material to fall to the side and down as the conveyor moved upwards. A metal pail was positioned underneath the conveyor return to collect whatever material fell back down. This may have been part of the reason why only a small amount of residue could be raked onto the conveyor at a time. Consequently the process was slowed down considerably.

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[1] Flow Diagram, Appendix C.4

As the residue reached the top of the conveyor a spray was used to wash the residue from the conveyor. This material fell onto a chute which fed the residue into the trommel.

Trommel and First Vibrating Screen

The trommel is a 10-foot-long, 3-foot-diameter, cylindrical punched plate screen with 1-1/4-inch diameter holes. Inside are four blades approximately 2 inches wide spanning the length of the trommel, which causes the residue material to tumble as the screen rotates. The trommel is elevated at the entrance which enables material larger than 1-1/4 inches to flow to the other end. All material smaller than 1-1/4 inches falls through the screen.

Paper caused a problem in the trommel by clogging the sprays and the screen. As the screen rotated, paper was carried up and dropped, accumulating on the pipes and spray heads inside, preventing the sprays from functioning and causing a dripping action from the sprays instead of the normal operation. Becausing there was no spraying action, paper also accumulated against the inside of the trommel screen, preventing material from falling through the holes in some areas of the screen.

The material smaller than 1-1/4 inches fell into a hopper directly under the trommel screen. Due to the shallow slope of the hopper sides and the malfunction of the sprays, material tended to build up under the entrance end of the trommel.

The hopper funnelled down to a one foot square opening allowing the material to fall onto a set of circular vibrating screens. This set of circular vibrating screens is typical of several throughout the system. It was compreised of three compartments, each at a different level. The top screen received the minus 1-1/4 inch and +4 mesh material. Discharge was to a chute and onto a belt conveyor which transferred the material up to the first shredder. The middle screen received the -4 and +20 mesh material. Discharge was to a chute and into a screw conveyor, which transferred this material to the bucket conveyors located after the shredder. This conveyor emptied into the secondary vibrating screen (described later). The -20 mesh material was discharged into a pump which pumped the material into a spiral classifier.

Primary Shredder

The material larger than 1-1/4 inches passed through the trommel onto a conveyor belt that transferred the material to the shredder. Shredder was a hammermill type rated at 30 hp. One of the plant personnel was assigned to remove all paper, grass, organic, large metal and wire as it passed along the picking conveyor. Food, paper, grass and other organics were placed in a nearby pail and the bulky metals and wire went into another. Huge and heavy metals, such as automobile parts and tools, could not be shredded in the small shredder. Also grass could coat the hammers of the shredder causing a cushion to form as the material was shredded. In order to protect personnel from flying particles a plywood partition was erected at a primary shredder. These problems would not be experienced at a full scale plant. No manual picking would be allowed.

The primary shredder also received the minus 1-1/4 inch and +4 mesh material previously described.

Second Vibrating Screen

From the shredder the material fell into a bucket conveyor which emptied onto the second set of circular vibrating screens. This set of vibrating screens was also comprised of three layers. The top screen received the +4 and +20 mesh material from the shredder, and also the -4 and +20 mesh by belt conveyor from the screens under the trommel hopper. The +4 mesh material from this second set of screens discharged to a chute and onto a vibrating feeder. The -4 and +20 fell through to the second screen where it was vibrated into a chute which emptied into a screw conveyor. The -20 mesh material passed through the -4 and +20 mesh screen and discharged into a vertical pump from where it was pumped to the spiral classifier.

First Drum Magnetic Separator

A vibrating feeder, 42 inches long by 10 inches wide, spread both the +4 mesh ferrous and non-ferrous metals, and other material prior to the magnetic separator. As the material arrived at the edge of the feeder, the ferrous metal jumped onto the magnetic drum. The magnetic metal adhered to the drum.

As the drum started its downward turn the metal left the magntic field and dropped into a barrel where the +4 mesh magnetic metal was collected.

There is no further processing done to the +4 mesh magnetic metal. It can be marketed as is.

Secondary Shredder

The nonmagnetic metals and materials which fell off the vibrating feeder dropped into a hopper under the magnetic separator and then into another bucket elevator. This bucket elevator carried the materials into a second hammermill. This device was a 7-1/2 hp machine for fine shredding. It was observed that the plant has had trouble with this material dropping from the bucket elevator into the hopper which feeds the smaller hammermill. Because the angle of slope was not great enough, there was some build-up causing the materials to clog the hopper.

Third Set of Vibrating Screens

After the materials came out of the small hammermill, they dropped onto another set of circular vibrating screens, comprised of three layers. The top screen discharged the +4 mesh non-ferrous metal and other materials into a barrel. The middle screen discharged the -4 and +20 mesh materials into a barrel which was manually dumped into the screw conveyor which feeds the -4 and +20 mesh material to another magnetic drum separator. In the event that the +4 non-ferrous requires further processing it is taken to the vibrating feeder prior to the first drum magnetic separator and thence through the small hammermill. The -20 mesh material is pumped to a spiral classifier.

It was noted that there was accumulation of materials on the screen. The peripheral discharge circular screens do not appear satisfactory. Discussions with plant personnel indicate rectangular, inclined screens may be preferable for a full scale plant.

Second Drum Magnetic Separator

A screw conveyor dropped the -4 and +20 mesh material onto the top of the second magnetic separator. As the separator rotated downward, the non-ferrous metal and other non-magnetic material was washed off by sprays directed at the drum into another small screw conveyor. The -4 and +20 mesh ferrous metal adhered to the magnetic drum until the drum started its upward turn. The metal then left the magnetic field and dropped into a barrel. The small screw conveyor had a water overflow into a drum. This drum was rigged with a smaller drum inside used for filtering.

Rod Mill and Fourth Set of Vibrating Screens

The small screw conveyor fed the material into a rod mill. This mill finely ground the glass and produced flattened particles of non-ferrous metal. The rod mill discharged onto a circular vibrating screen which was fitted with one screen. A +20 mesh screen accumulated the non-ferrous metal products, and the -20 fraction passes to the high intensity magnetic separator for the glass separation. This is the glass product.

Water Reclamation and Treatment

Any water that overflows any part of the system and is not recycled goes to a drainage system that runs underneath the floor. It is filtered before being pumped to the sewer system. Grass can accumulate in this filter and due to its small size can clog the system. Grass is a major problem in most of the tests in the existing pilot plant.

The -20 mesh materials from the various screening locations and waste waters are pumped to the water reclamation system section. This was located on top of the platform near the trommel and directly underneath the platform.

4.5.3 Second Test

One of the main objectives for attending the second processing of residue at the Bureau of Mines plant was to obtain information on the water reclamation system, and to observe the glass separation by the magnetic separators.

It was observed that the hydro-classifier was not being used as it was during the first test.

The sand classifier was modified to include a small hopper above a tray which fed a white powdered substance into the water in the spiral classifier. The white powder, a sodium carbonate and ferrous sulfate combination, was used to aid in the floccuation.

During the run, while the residue was being processed, two main pieces of equipment of the plant experienced operating difficulty. The bucket elevator underneath the primary shredder jammed, but was repaired within half an hour. The belt conveyor feeding the primary shredder with +4 mesh material which is discharged through the trommel had to be shut down. The material was not being carried upward, probably due to the angle of incline or the characteristics of the material.

Improvements were made to the belt conveyor that fed the trommel. Sides were added to the belt conveyor frame enabling the material to roll to the center of the belt where the blade is.

The top screen of the set of screens underneath the trommel discharged the material onto a belt conveyor approximately 8 inches wide. Further observations of this conveyor revealed that the material was mostly round objects, and as the material was conveyed up to the shredder, the round objects would tend to roll backwards; sometimes bouncing completely off the conveyor onto the floor. At the bottom of the conveyor excessive accumulation existed. Due to a lack of protection, material had also gathered underneath the belt.

The second screen discharged +20 material into a screw conveyor approximately 6 inches in diameter. This screw conveyor discharged the material into the bucket elevator under the shredder.

Fresh water is introduced into the processing system at two locations.

1. Rod mill

2. Matrix-type magnetic separator

The rod mill receives the majority of fresh water. At the rod mill the fresh water was directed through three branches: one spray directed at the rod mill entrance where the material is washed off a slide chute and into the rod mill and two sprays are directed at the vibrating screen under the rod mill to break up accumulations of material.

Clear and colored glass particles are separated from each other utilizing techniques based on the magnetic property of the colored glass. At the matrix-type magnetic separator fresh water was introduced onto the classifier as it rotated. Fresh water was added to aid in washing the particles through the rotating disk. In addition, water with ground glass fragments discharged from the rod mill was pumped to this separator. There are two spray discharges onto the rotating disk. As the rotating disk turned magnetic particles adhered to the metal ball bearings until they passed out of the magnetic field. The particles then dropped into a trough. The non-magnetic glass particles are dropped into a separate trough.

The clear glass was further cleaned. The clear glass recovered from the matrix-type magnetic separator was piped to a high intensity magnetic flux. This device works on the same principle as the matrix-type separator but is more powerful, having a magnetic field strength of 20,000 gauss instead of 3,000 gauss.

As the glass product was sprayed onto the rotating disk the clean glass dropped through the disk and the magnetic glass product adhered to the disk until it passed out of the magnetic field.

These two products were collected in 55-gallon drums with an overflow system allowing the glass to settle at the bottom. The overflow water from the colored glass drum was pumped to the second magnetic drum separator. It was used to wash the magnetic drum free of any non-ferrous material. From the classifier the water flowed into a drum and was pumped to the bucket elevator under the shredder.

The material from these buckets was dropped onto a set of vibrating screens. From the bottom screen the water was pumped to the spiral classifier used in dewatering sand. Water from the trommel was also pumped to this location.

The sand spiral classifier had an overflow system that sent the water to the thickener. In this device the slimes were taken out of the water. The remaining water was pumped to the trommel. The water employed in the trommel was used to wash fine material through the trommel and into the hopper.

At other locations in the plant where water sprays are employed, recycled water is used.

4.6 Results of Refuse and Residue Tests

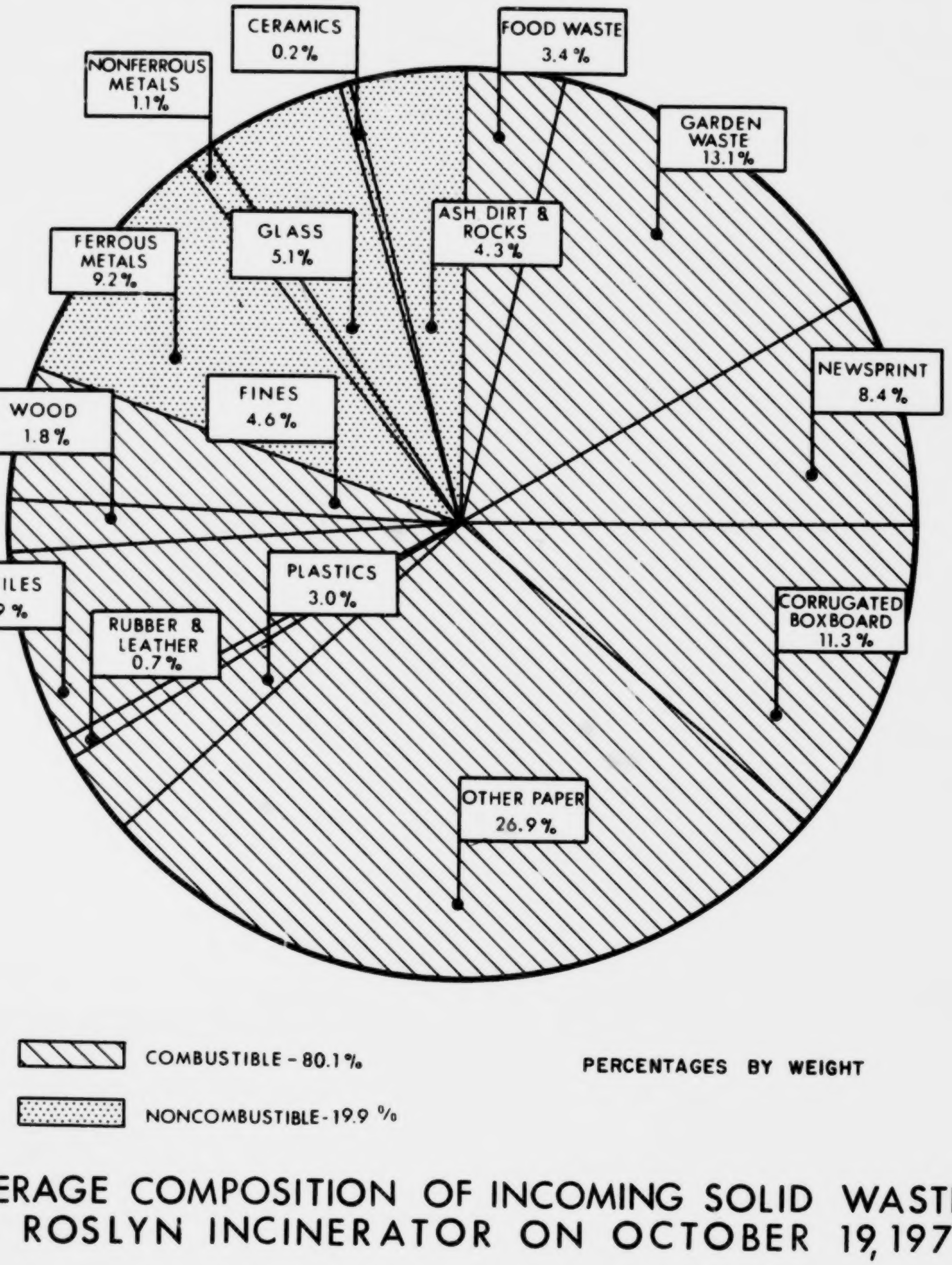
4.6.1 Refuse Analysis

The incoming refuse on October 19, 1971 produced percentages of components as summarized in Figure 4-2. These percentages were compared to other localities in the country and to national averages as shown in Figure 4-3.

The results of these tests did not deviate significantly when compared to other analyses across the country.

4.6.2 Residue Analysis

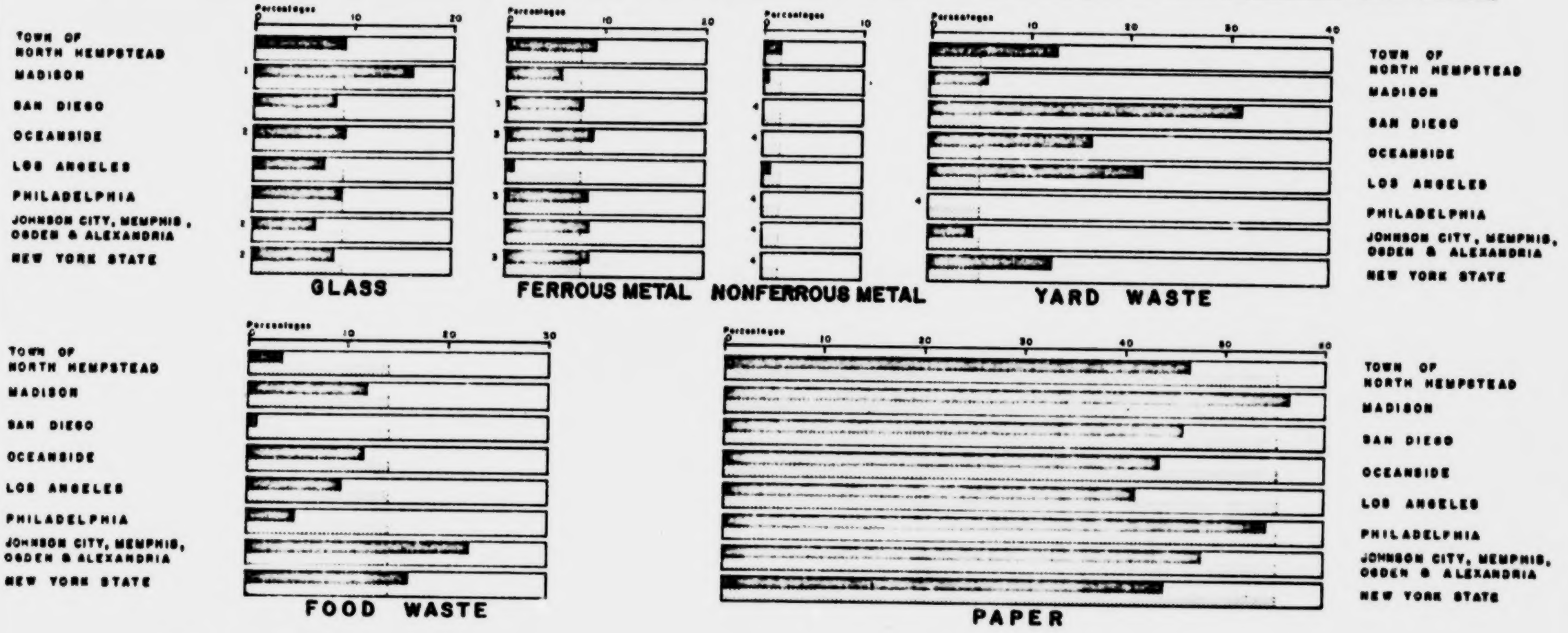
Table 4-1 presents the residue materials balance from the two tests at the Roslyn incinerator. The raw data presented for Test 1 is as reported by the Bureau of Mines. The adjusted percentages for Test 2 were developed using a ratio of residue weights shipped to the Bureau of Mines for the two tests.



AVERAGE COMPOSITION OF INCOMING SOLID WASTE AT ROSLYN INCINERATOR ON OCTOBER 19, 1971

FIGURE 4-2

COMPARISON OF REFUSE COMPOSITIONS[5] BY LOCALITY AND NATIONAL AVERAGE



SOURCE OF DATA

TOWN OF NORTH HEMPSTEAD, N.Y.
Incoming Solid Waste at Roslyn Incinerator
On October 19, 1971

MADISON, WIS.
"Preliminary Separation of Metals and Non-Metals
From Urban Refuse" (Bureau of Mines Technical
Progress Report TPR-34)

SAN DIEGO, CALIF.
"Recovery and Utilization of Municipal Solid Waste
(Report SW-10c U.S. Environmental Protection
Agency, Solid Waste Management Office 1971)

OCEANSIDE, N.Y. and PHILADELPHIA, PA.
"Municipal Incinerator Refuse and Residue" by
E.R. Kaiser, C.D. Zeit, J.B. McCaffery 1968

LOS ANGELES, CALIF.
"Los Angeles Shatters Illusion of Revenue from Wastes"
By Charles E. Imel and Michael Miller
(Solid Wastes Management, July, 1971)

JOHNSON CITY and MEMPHIS, TENNESSEE,
OGDEN, UTAH, and ALEXANDRIA, VA.
"Environmental Wastes Control Manual - 1971"
(Public Works Journal)

NEW YORK STATE
"The Nature of Municipal Solid Waste"
(Arthur D. Little, Inc., May 1969)

NATIONAL AVERAGE
"Recovery and Utilization of Municipal Solid Wastes"
(Report SW-10c U.S. Environmental Protection Agency,
Solid Waste Management Office, 1971

LEGEND

▨ NATIONAL AVERAGE

▢ LOCALITY

FIGURE 4-3

NOTES

1 Includes dirt
2 Includes ceramics
3 Includes nonferrous
4 Information not available
5 Percentages by weight

The breakdowns for Test 2 are felt to be more characteristic of the operation of the Roslyn incinerator since:

1. The higer percentage of wet grass was not experienced during Test 2.

2. The operating state of the rocker grate furnace was at its peak following a major repair.

3. The Bureau of Mines pilot plant did not experience difficulty in the magnetic separation devices during Test 2. According to the Bureau, electrical power problems contributed to the poor quality of separation experienced during Test 1.

Figure 4-4 illustrates the residue composition as experienced during Test 1.

The categories and percentages of recovered products during the tests are summarized in Table 4-2. These percentages were utilized in the plant sizing and layout of equipment for a full scale plant for North Hempstead.

The chemical analyses for ferrous and non-ferrous metals of the North Hempstead residue, as provided by the Bureau of Mines, are shown in Tables 4-3 and 4-4. These assays include the results of both tests.

TABLE 4-1

MATERIALS BALANCE
ROSLYN INCINERATOR

	Test No. 1 - Traveling Grate Furnace									Test No. 2 - Rocking Grate Furnace					
	Residue			Siftings[1]			Total[5]			Residue		Adj. Siftings Quantities for Test #2[6]		Total	
	Dry Wt.		Adjusted Wt. %[3]	Dry Wt.	Wt. Adjusted to Test Time[4]		Dry Wt.		Adjusted Wt. %	Dry Wt.		Dry Wt.		Dry Wt.	
PRODUCTS	lbs.	%		lbs.	lbs.	%	lbs.	%		lbs.	%	lbs.	% (Test No. 1)	lbs.	%
Massive iron	576.4	9.5	13.0	-	-	-	576.4	9.2	12.3	362.5	9.9	-	-	362.5	9.5
Plus 4-Permanent drum magnetics	675.1	11.2	15.4	23.0	17.6	7.1	692.7	11.0	14.8	602.0	16.5	10.6	7.1	612.6	16.1
Plus 20-Electro-drum magnetics	185.5	3.1	4.3	22.0	16.8	6.9	202.3	3.2	4.3	174.1	4.8	10.1	6.9	184.2	4.8
Plus 4-Coarse nonferrous metals	54.6	.9	1.2	17.5	13.4	5.5	68.0	1.1	1.5	17.2	.5	8.1	5.5	25.3	.7
Plus 20-Fine nonferrous metals	76.9	1.3	1.8	6.5	5.0	2.0	81.9	1.3	1.8	16.4	.4	3.0	2.0	19.4	.5
Nonmagnetic glass	1,122.5	18.6	25.5	97.0	74.1	30.2	1,196.6	19.1	25.6	762.4	20.9	44.8	30.2	807.2	21.3
Magnetic glass	636.4	10.5	14.4	75.0	57.4	23.4	693.8	11.0	14.9	587.0	16.1	34.7	23.4	621.7	16.4
Classifier sands	807.4	13.3	18.3	78.5	60.0	24.5[2]	867.4	13.8	18.6	654.8	17.9	36.2	24.5	691.0	18.2
Filter cake	1,020.9	16.9	6.1	-	-	-	1,020.9	16.2	6.2	394.6	10.8	-	-	394.6	10.4
Unburned paper	592.0	9.8	-	-	-	-	592.0	9.4	-	79.5	2.2	.7	-	80.2	2.1
Grass, plus organics	295.0	4.9	-	1.5	1.1	.4	296.1	4.7	-	-	-	-		-	
TOTAL	6,042.7	100.0	100.0	321.0	245.4	100.0	6,288.1	100.0	100.0	3,650.5	100.0	148.2		3,798.7	100.0
ADJUSTED TOTAL	4,403.6[3]														

Test No. 1
Wet weight = 9,716 lbs.
Moisture = 37.8 %
Dry weight = 6,042.7 lbs.

Test No. 2
Wet weight = 4,493.5 lbs.
Moisture = 18.8%
Dry weight = 3,650.5 lbs.

NOTES

1 Grate siftings sample (collected over 8 hour period).

2 Contains fines, but not enough to filter.

3 Adjusted weight percent assumptions:
Assume only filter cake required adjustment for unburned grass, etc. (6042.7 - 295.0)
Assume filter cake to sands ratio = 1:3 .. Adj. FC = 807.4 ÷ 3 = 269.1.. Unburned grass, etc. in filter cake is (1020.9 - 269.1)= 751.8, Adjusted Total = (6042.7 - 295.0 - 592.0 - 751.8) or 4403.9
Assume complete burnout except for carbon in filter cake.

4 Adjustment required for ratio of residue sample collection time to sifting collection time. (6.5:8.5)

5 Total of samples of residue plus siftings adjusted for residue sampling period.

6 Test No. 2 siftings were not measured. Instead the siftings are figured from test No. 1 as proportional to the residue.

$\frac{\text{Residue Test \#2}}{\text{Residue Test \#1}} = \frac{3650.5}{6042.7} = .604$, .604 x (Adjusted Siftings Test #1)= Adjusted Siftings Test #2

CATEGORIES AND PERCENTAGES OF RECOVERED PRODUCTS

TABLE 4-2

Products recovered	U.S. Bureau of Mines Averages Materials produced Pounds per hr.	Weight-percent	Cumulative weight - percent	Test No. 1 - Traveling Grate 1] Materials produced minus siftings Pounds per hr.	Weight-percent	Cumulative weight - percent	Test No. 1 - Traveling Grate 2] Materials produced plus siftings Pounds per hr.	Weight-percent	Cumulative weight - percent	Test No. 2 - Rocking Grate 1] Materials produced minus siftings Pounds per hr.	Weight-percent	Cumulative weight - percent	Test No. 2 - Rocking Grate 2] Materials produced plus siftings Pounds per hr.	Weight-percent	Cumulative weight - percent
Massive iron and wire	30	3.0	3.0	130	13.0	13.0	123	12.3	12.3	99	9.9	9.9	95	9.5	9.5
Plus 4-mesh magnetics	136	13.6	16.6	154	15.4	28.4	148	14.8	27.1	165	16.5	26.4	161	16.1	25.6
Plus 4-mesh nonferrous metals	17	1.7	18.3	12	1.2	29.6	15	1.5	28.6	5	.5	26.9	7	.7	26.3
Minus 4- plus 20-mesh magnetics	139	13.9	32.2	43	4.3	33.9	43	4.3	32.9	48	4.8	31.7	48	4.8	31.1
Minus 4- plus 20-mesh nonferrous metals	11	1.1	33.3	18	1.8	35.7	18	1.8	34.7	4	.4	32.1	5	.5	31.6
Minus 20-mesh nonmagnetic glass	289	28.9	62.2	255	25.5	61.2	256	25.6	60.3	209	20.9	53.0	213	21.3	52.9
Minus 20-mesh magnetic glass	207	20.7	82.9	144	14.4	75.6	149	14.9	75.2	161	16.1	69.1	164	16.4	69.3
Minus 20-mesh classifier sands	159	15.9	98.8	183	18.3	93.9	186	18.6	93.8	179	17.9	87.0	182	18.2	87.5
Thickener slimes 3]	12	1.2	100.0	61	6.1	100.0	62	6.2	100.0	130	13.0	100.0	125	12.5	100.0
Composite	1,000	100.0	-	1,000	100.0	-	1,000	-	-	1,000	-	-	1,000	100.0	-

1] Results reported by Bureau of Mines as adjusted.
2] Results obtained using Bureau of Mines adjustments.
3] For Test No. 1 this value is taken as reported for filter cake; For Test No. 2 it includes filter cake and unburned paper, plus organics

TABLE 4-3

CHEMICAL ANALYSIS OF FERROUS METALS

METAL CONSTITUENT	TEST NO. 1 (%)			TEST NO. 2 (%)			AVERAGE (%)		
	Coarse	Fine	Combined*	Coarse	Fine	Combined*	Coarse	Fine	Combined
IRON (Fe)	98.0	99.0	98.22						
COPPER (Cu)	.47	.57	.49	.05	.69	.19	.26	.63	.34
TIN (Sn)	.23	.18	.22	.30	.13	.26	.27	.16	.24
LEAD (Pb)	.01	.01	.01						
SILICON (Si)	.10	.09	.10	.06	.57	.17	.08	.33	.14
CARBON (C)	2.17	.98	1.91	2.25	.63	1.89	2.21	.81	1.90
SULFUR (S)	.03	.08	.04	.01	.04	.02	.02	.06	.03
TOTAL	101.01	100.91	100.99						

*Based on actual weights of coarse and fine products recovered (e.g. for Fe in Test No. 1

$$\frac{(675.1 \times .98) + (185.5 \times .99)}{675.1 + 185.5} \times 100 = 98.22\%)$$

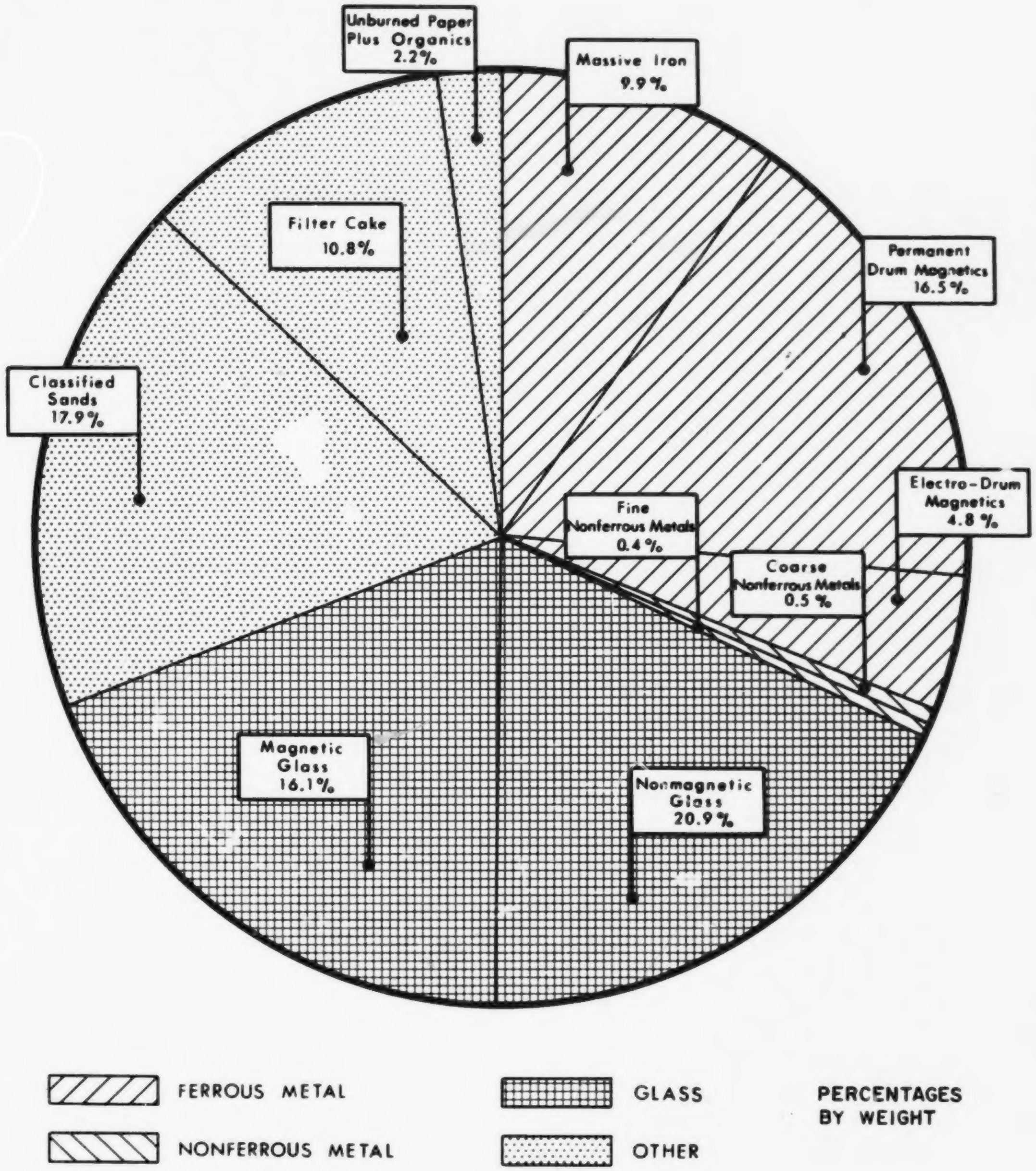
TABLE 4-4

CHEMICAL ANALYSIS OF NON-FERROUS METALS

METAL CONSTITUENT	TEST NO. 1 (%)			TEST NO. 2 (%)			AVERAGE (%)		
	Coarse	Fine	Combined*	Coarse	Fine	Combined*	Coarse	Fine	Combined
Al (Aluminum)	59.9	62.8	61.2	41.6	65.4	53.2	50.3	64.1	57.2
Cu (Copper)	17.7	6.3	11.0	36.4	14.0	25.5	27.1	10.2	18.3
Mg (Magnesium)	.11	.10	.11	.05	.02	.04	.08	.06	.07
Zn (Zinc)	13.8	11.3	12.3	14.2	7.9		14.0	9.6	
Mn (Manganese)	.28	.28	.3	.24	.47	.4	.3	.4	.4
Pb (Lead)	3.65	1.14	2.2	.76	1.74	1.2	2.2	1.4	1.7
Si (Silicon)				.41	.67	.5			
Fe (Iron)				3.45	3.00				
TOTAL	94.44	81.92	87.1	97.11	93.2	95.14	93.98	85.76	87.37

*Based on actual weights of coarse and fine products recovered (e.g. for Al in Test No. 1

$$\frac{(54.6 \times .589) + (76.9 \times .628)}{54.6 + 76.9} \times 100 = 61.1\%)$$



COMPOSITION OF RECOVERED RESIDUE
AT ROSLYN INCINERATOR ON DECEMBER 6, 1971

FIGURE 4-4

CHAPTER 5

MARKETING INVESTIGATIONS

5.1 Ferrous

5.1.1 Utilization of Ferrous Scrap

There has been a rapid increase in raw steel consumption since 1920, from 23 million tons in 1920 to 140 million tons in 1971. The yearly fluctuations and increases are graphed in Figure 5-1, "Steel and Scrap Tonnage Fluctuations". Notwithstanding certain recessional dips, the trend is clearly toward increased raw steel consumption at the historical rate of increase, an increase of 600% in half a century, over 100% per decade. The same figure shows the manner in which the two less accentuated curves, for scrap consumption and purchased scrap consumption, follow the increase in raw steel consumption, by dips and peaks, and by general trend. Scrap consumption increased by approximately 800% in 50 years, purchased scrap consumption increased between 400 and 500%. The trend of increase is clear, as each successive dip is generally lower than those preceding, and each successive peak is higher. The dips and peaks and overall trends for purchased scrap consumption occur at the exact same years and over the exact same periods as those for overall scrap consumption.

Scrap iron price data, also plotted from 1921, does not show the firm trend of the tonnage fluctuations. The yearly price averages are tabulated in Appendix D. Figure 5-2, "Scrap Iron Price Fluctuations", shows the extreme peaks and dips in scrap iron prices for the first eleven years after World War II. These extreme peaks are not part of any previous or later historical pattern and are not expected to repeat. An overall upward price trend is discernable since 1921, the price for "heavy melting steel" increasing from $12 or $13 to $25 or $30 per gross ton. The price for "number 2 bundles" appears to have stabilized since the post-war period, from when figures are first available, at between $20 and $28 per gross ton.

The advent of the electric-arc furnace has favorably affected scrap consumption. During the most recent five years for which figures are available, 1965-1969, typical furnace charges were composed of from 97% to over 99% scrap. While open hearth furnace steel production has declined from 87.4% of total steel production in 1954 to 43.2% in 1969, basic oxygen and electric furnace production have increased to 42.7% and 14.1% in 1969 from 1.9% and 9.1%, respectively, in 1954. The rapid decline in open hearth production, which utilized 40% to 45% scrap, forced the price of scrap down. The big new basic oxygen furnaces utilize only 29% to 30% scrap. Since scrap constitutes almost the entire charge material for an electric furnace, these reduced scrap prices have encouraged electric furnace production.

Two other factors are favorable to electric furnace production: small scale and reduced power rates. The small scale mills built around the United States specialize in the widely used, but scattered and small volume products. They also have the ability of utilizing the scattered raw material, scrap, nearer to its source. The small electric steelmakers can operate successfully at capactiies far below those of basic oxygen furnaces, at less investment in capital. Electric furnace production continues to benefit from reducing electric power costs and improvements in electric power application. These "miniplants", formerly producing under 100,000 tons of steel per year, are now being designed with an annual production of up to half a million tons. The Institute of Scrap Iron and Steel, Inc. (ISISI) predicts that by 1999 electric furnace steel production will account for 36% of total U.S. raw steel production.

Prereduced iron ore is expected to have a significant effect on future scrap consumption. If the degree of metallization is high enough, prereduced iron ore may serve as synthetic scrap. It is expected, according to ISISI, that conventional steelmaking processes will dominate the 1970's, with production changes reflecting only refinements of the oxygen blowing technique. By 1973, it is expected that the effectiveness of prereduced ore operations will be demonstrated; prereduction will be widely applied by 1977 and fully proven by 1980. High-powered electric furnaces, coupled with prereduction, will then constitute an increasing user of mixed charges of scrap and metallized ores until the turn of the century.

It is expected, however, that prereduced iron ores will not be widely available until 1975. By the late 1970's, scrap utilization in electric furnaces will be reduced to about 80%. When the potential demand for prereduced iron ore is fully met in 1985, the average electric furnace input will be about 40% scrap and 60% prereduced ore. This is reflected in the dip in scrap steel and purchased scrap steel tonnages in Figure 5-1, culminating in the low point in 1985. Following 1985, a steady increase in consumption of both scrap and metallized ore is expected, reflected in the upswing on the graph.

Ultimately, prereduction will favor scrap consumption, by favoring the construction of electric furnaces at the expense of oxygen furnaces. It is predicted by ISISI that, since mixtures of scrap and prereduced ore give faster heats and perform better than either alone, the two "raw materials" will increase in use in a complementary manner. Furthermore, this mixture performance will contribute to the elimination of the air pollution problem.[1]

As noted by the James Flett Organization[2], continuous casting should also have a favorable effect on purchased scrap use since this process produces far less home scrap than does ingot pouring. If there is less home scrap for recycling, the resulting contaminant residual buildup will be less, and one of the objections to purchased scrap - its contaminant contribution to residual buildup in home scrap - will be overcome.

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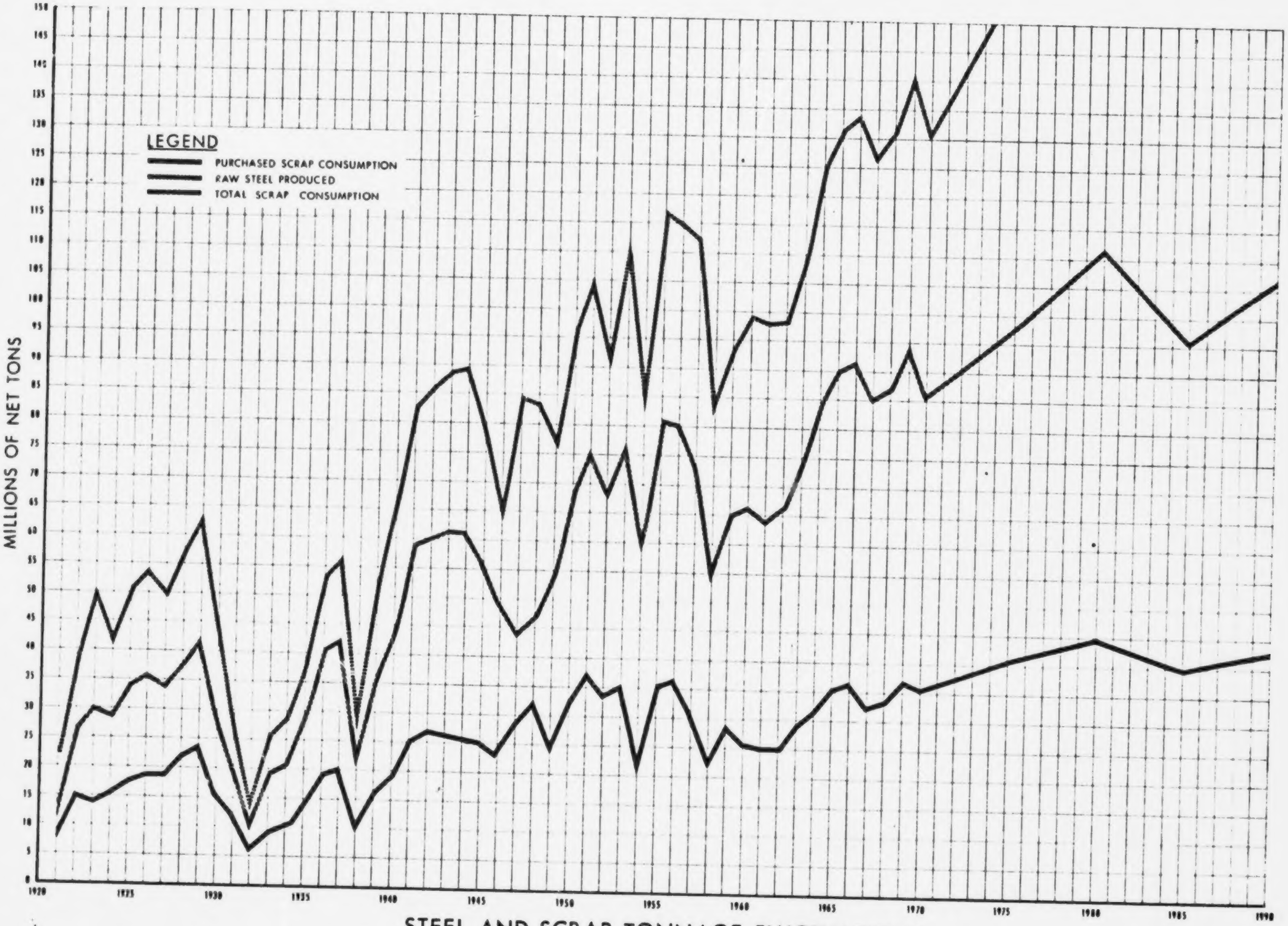
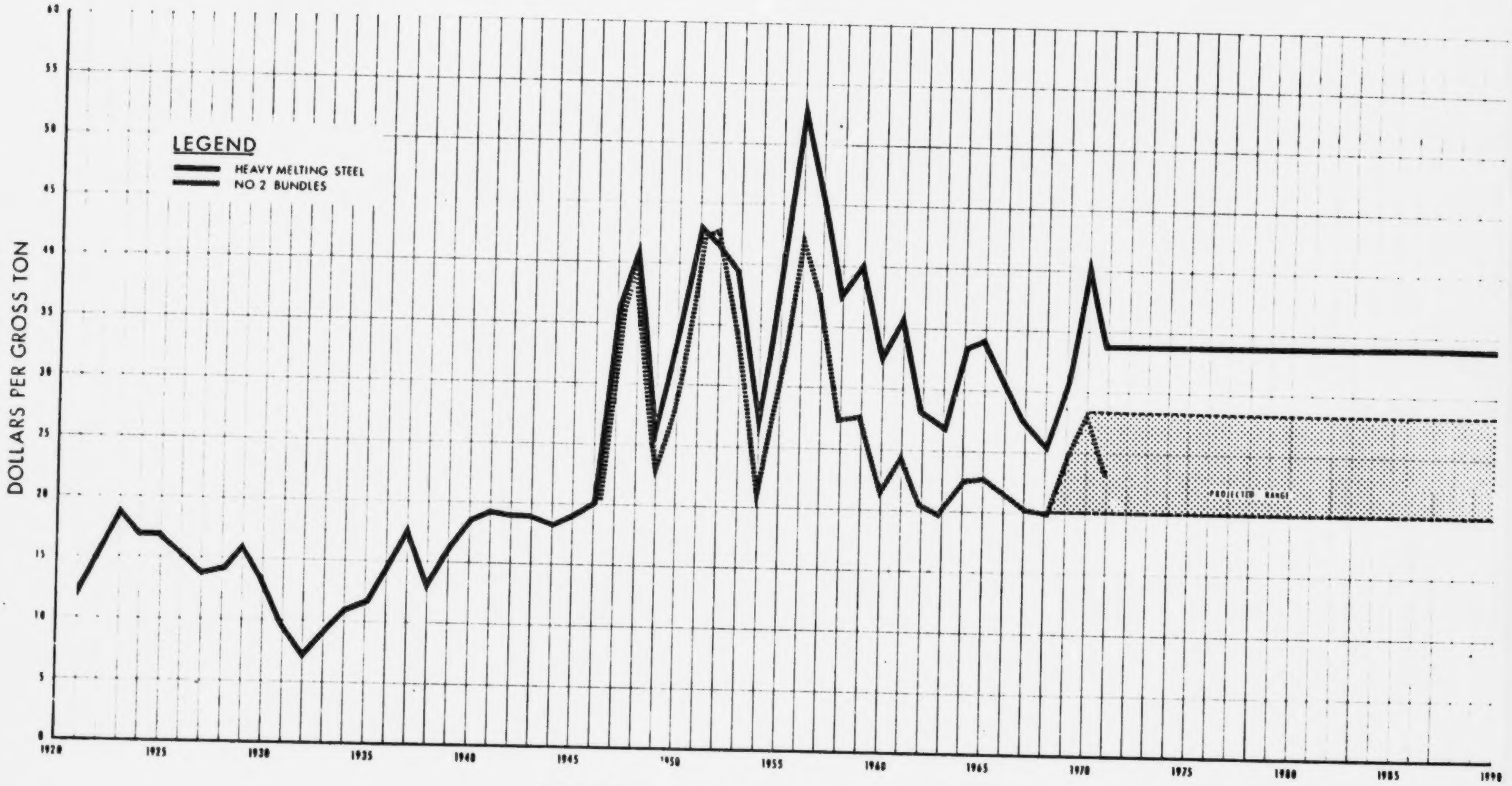
[1] Miller, Jack Roberts. "Scrap, Prereduced Iron Ore, and Electric Furnace Steelmaking in the 1970 Decade." Facts (31 Ed.), Institute of Scrap Iron and Steel, Inc., 1970, pp 84-87

[2] Appendix A



STEEL AND SCRAP TONNAGE FLUCTUATIONS
1921 TO 1970 AND PROJECTED 1971 TO 1990

FIGURE 5-1



SCRAP IRON PRICE FLUCTUATIONS
1921 TO 1970 AND PROJECTED 1971 TO 1990

FIGURE 5-2

Transportation costs are critical to the marketability of ferrous scrap. Much has been written, since the recent national interest in recycling, about the inequity of freight rates. A new study made for the Institute of Scrap Iron and Steel by Battelle Columbus Laboratories[1] concluded "that the rate differentiation inherent to the existing railroad rate structures of 1966[2] amounts to an average of $1.49 per gross ton in additional charges assessed on the movement of iron and steel scrap" as compared with virgin ore.

5.1.2 Markets for Ferrous Residue in Producing Pig Iron

A potential market exists for ferrous residue as blast furnace feed in the production of pig iron. The most promising development in this field was National Steel's demonstration at its Great Lakes' 3,000 TPD D4 blast furnace at Zug Island on January 3, 1972, when 37.5 tons of scrap cans from the residue of Chicago's municipal incinerators were charged at the test rate of 50 pounds of cans per ton of hot metal produced. Proler Steel Corp. magnetically separated the scrap cans from the residue.

The small pieces comprising non-baled can scrap may easily be handled by modern blast furnace charging equipment which ordinarily handles sintered or pelletized iron ore and rejects heavy scrap. Like pelletized ore, can scrap has the further advantage of porosity, allowing easy circulation of reducing gases.

National Steel maintains that the economics of collecting can scrap and getting it to the mill must compare attractively with the economics of ordinary feed material. "But," quotes their January 13, 1972 news release, "given the large concentration of cans which are available at municipal refuse dumping points and the ease and low-cost of separating them magnetically, the economic equation appears to be a promising one." The company reports no iron chemistry or other problems and is continuing to experimentally increase the percentage of cans to determine the maximum. National Steel has assured us as a result of their tests that ferrous metallics recovered from either raw refuse or incinerator residue can feasibly be recycled in the blast furnace. Economic and processing details furnished by National refer to their basic oxygen steelmaking furnace, and are therefore treated under the section on steel production.

Huron Valley Steel Corp. of Belleville, Michigan, has been operating a non-conventional blast furnace producing 125,000 tons of pig iron a year from No. 2 scrap steel. Before National Steel began experimental production in this line, Huron Valley's operation, launched in 1960, was the only one in America, creating merchant pig iron from such scrap. For five years, their plant handled tin cans from all the incinerators in the Detroit area and converted 157,000 tons into pig iron which was sold to the auto industry. The plant was closed because the company could not get enough cans to afford the required air pollution control improvements.

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[1] "Freight Rates Hinder Scrap Markets by Encouraging Use of Ore, Study Finds" Environmental Reporter, 1972, p 1144

[2] Latest figures from Interstate Commerce Commission, used in report cited

Huron Valley has processed the entire residue produced by Detroit's incinerators, separating the ferrous component for blast furnace feed. This company has expressed an interest in working with the Town in the establishment of a facility for separation of metals from residue. They feel that the basic principle underlaying the Bureau of Mines approach is sound and can be implemented effectively, but that the system requires extensive changes. Huron Valley, however, has not expressed any current interest in accepting the ferrous fraction of our residue as blast furnace charge. The company also proposes to separate ferrous residue and process it in an electric-arc furnace.

5.1.3 Markets for Ferrous Residue in Steel Production

The best potential market for the ferrous fraction recovered from incinerator residue is in steelmaking, for consumption by the basic oxygen and electric-arc furnaces. At its Weirton and Granite City Steel Divisions, National Steel Corp. has been recycling scrap steel cans in its basic oxygen process (BOP) since 1970. Recently, this firm demonstrated its capacity to handle scrap steel cans in an electric steelmaking furnace. National has successfully recycled incinerated ferrous metal at its Detroit, Michigan plant.

National Steel presently feels that incinerated ferrous is probably more readily adaptable for reuse then non-incinerated ferrous, in view of the work conducted to date in the recovery of this material. The firm's experience is that they are unable to use non-incinerated ferrous metal when the only processing used is magnetic separation. The firm contends that such non-incinerated ferrous metals are contaminated with paper, organics, aluminum and other materials and that if this ferrous can be cleaned, including aluminum removal and possibly lead removal, it can then be used is steelmaking.

By a February 1, 1972 telegram and a March 1, 1972, letter, National Steel Corp. confirmed that ferrous scrap material separated from incinerated municipal solid waste by the U.S. Bureau of Mines pilot plant is a usable product. The company stated that it could accept 1200 tons per month of this type of scrap at its Weirton, West Virginia plant under present conditions. Although no purchase order or firm commitment has been made, Nation Steel has vouched that, if an when this material is available, the company will consider the purchase of the material at competitive scrap prices in accordance with its metallurgical value, assuming no change in market conditions.

National Steel's test work has led them to state that it is now possible to recycle ferrous metallics recovered from raw refuse and incinerator residue in the basic oxygen furnace, electric steelmaking furnace or blast furnace in limited quantities depending upon the material's physical and metallurgical specifications. In tests involving incinerated scrap from other sources, numerous problems were encountered. The firm believes, however, that these problems, listed below for the steelmaking industry, can be overcome.

Problems Encountered by National Steel in Utilizing Incinerated Scrap in Steelmaking

Copper Levels	Copper levels are high. Maximum tolerable level is 0.5%.
Tin	Incineration alloys tin to steel so that it cannot be detinned.
Aluminum	Aluminum heat damages furnace refractories.
Nickel and Molybdenum	These alloys remain in the home scrap that is recycled and gradually build up as a portion of each heat is recycled.
Bulk density	Bulk density has ranged from 22 to 77 pcf. This fluctuation must be stabilized. A level of 140 pcf is desirable, but 75-80 pcf is probably economically feasible. Briqueting or compaction is required and cylindrical briquets, 4 to 6 inches in diameter, approximately 6 inches long, are suitable, but 6" x 6" cubes may be used in almost any process.
Cleanliness	Some incinerated ferrous processed contained up to 16% dirt and glass and similar contaminants. This material must be washed, scrubbed and/or otherwise removed from the ferrous fraction and the ferrous baled to prevent excessive oxidation.
Yield	81 to 97% of the incinerated ferrous has been recovered as iron. National Steel requires 98 to 99% iron recovery.

It is essential that the marketed ferrous residue fraction be classified accurately and advantageously for sale and shipment. Most of the opinions of potential users regarding pricing have been that North Hempstead's material will fit the classification of No. 2 bundles with a price adjustment for metallurgy. The material must be adequately compressed to meet this specification. The Institute of Scrap Iron and Steel, Inc. specifies, "Any deviations from the general classifications of iron and steel scrap may be consummated by mutual agreement between buyer and seller." Thus a price adjustment for metallurgy would be reasonable. None of the sales contacts made, except U.S. Steel, advised classification as "Incinerator bundles", another of the ISISI specifications. The two classifications referred to above apply to use by all of the basic large scale iron and steel processes: basic open hearth, basic oxygen, electric furnace and blast furnace.

The material would normally be classified as ferrous scrap for shipment. If this scrap were to be considered as equivalent to cinders from incinerators, then a new rate schedule would have to be developed with the railroads. Adequate briquetting is also necessary for economical shipment.

Alan Wood Steel Company

Alan Wood Steel Company also cooperated in the investigation. Wood initially said it was difficult for a large facility such as theirs to recycle metallics from diverse sources because of the unknown quantities of tramp metallics such as tin, copper or nickel, which are detrimental to steel quality. Non-metallics were also expected to be a problem. The firm suggested that the recycling problem would be less difficult for a "mini-mill" making lower quality products such as concrete reinforcing bars. Further discussions centered around the possibility of charging the relatively small volume of ferrous produced by North Hempstead with the 100,000 tons of raw materials the firm charges into its BOP but the firm cautioned that procedures required to prevent contamination might make use of ferrous unprofitable. After Wood requested a large sample for analysis, the firm determined from their tests on the sample that the North Hempstead scrap had too low an iron yield and too high a lead content for their use.

Specialty Steels

A reply from the firm of Allegheny Ludlum Industries, Inc. confirmed that the recovered material would have no application in the specialty steels industry.

Ferrous-containing Products

Potential markets were also sought with manufacturers of ferrous-containing products. One such contact, American-Standard, was unable to incorporate our recycled materials, considering the ferrous, non-ferrous and cullet. No markets for the ferrous residue have been located with any direct product-manufacturer.

Foundry Markets

Efforts were concentrated in locating a market with a major scrap user such as the large steelmakers, and the investigation of innumerable small foundries would have been impossible. Investigation of small foundries revealed an unwillingness to make any commitments or firm replies even though they were assured these would not be contractually binding.

United States Pipe and Foundry Company, which has its own blast furnaces in Birmingham, with 800 tons daily cupola capacity in Burlington, N.J., provided useful information in the preparation of the scrap material for market. In a November letter, although making no commitments, the firm summarized, "... if the material can be produced to a consistent and guaranteed analysis within rather close limits and in a form and size that is compatible with standard melting processes, then, in our opinion, you have a product able to compete in the conventional metal market." The firm cautioned, however, that significant phosphorous and iron oxide should be avoided and that zinc, copper, lead, tin and chrome were deleterious, although copper was added in some grades. United expected that the ferrous would be able to compete with the scrap grades, Plate and Structural Steel, Foundry Steel, No. 1 Cast Scrap, Mixed Cast and Stripped Motor Blocks. Size preparation, the company stated, should be to a minimum 1/2 inch thickness and 20 to 24 inches in either direction.

Other Steelmaker Responses

Bethlehem Steel Corporation aided in this marketability study for a period, some personnel having been already familiar with the Bureau of Mines process. At a Bethlehem, Pennsylvania conference, their technical and purchasing people advised that the steel plants could accept reasonable quantities of our scrap in certain mills. Bethlehem representatives were willing to buy the 1,000-1,200 tons per month of North Hempstead scrap for the mill at Steelton, Penna., and ventured that if circumstances in mid-1973 were similar to today's, they could purchase the residue scrap at prices competitive with their low-grade scrap. Briquetting was required, the suggested size being 24 x 24 x 30 inches, but 6 x 6 x 6 inches was also acceptable. Bethlehem representatives noted that if this material was not handled by the scrap industry, the firm would purchase directly.

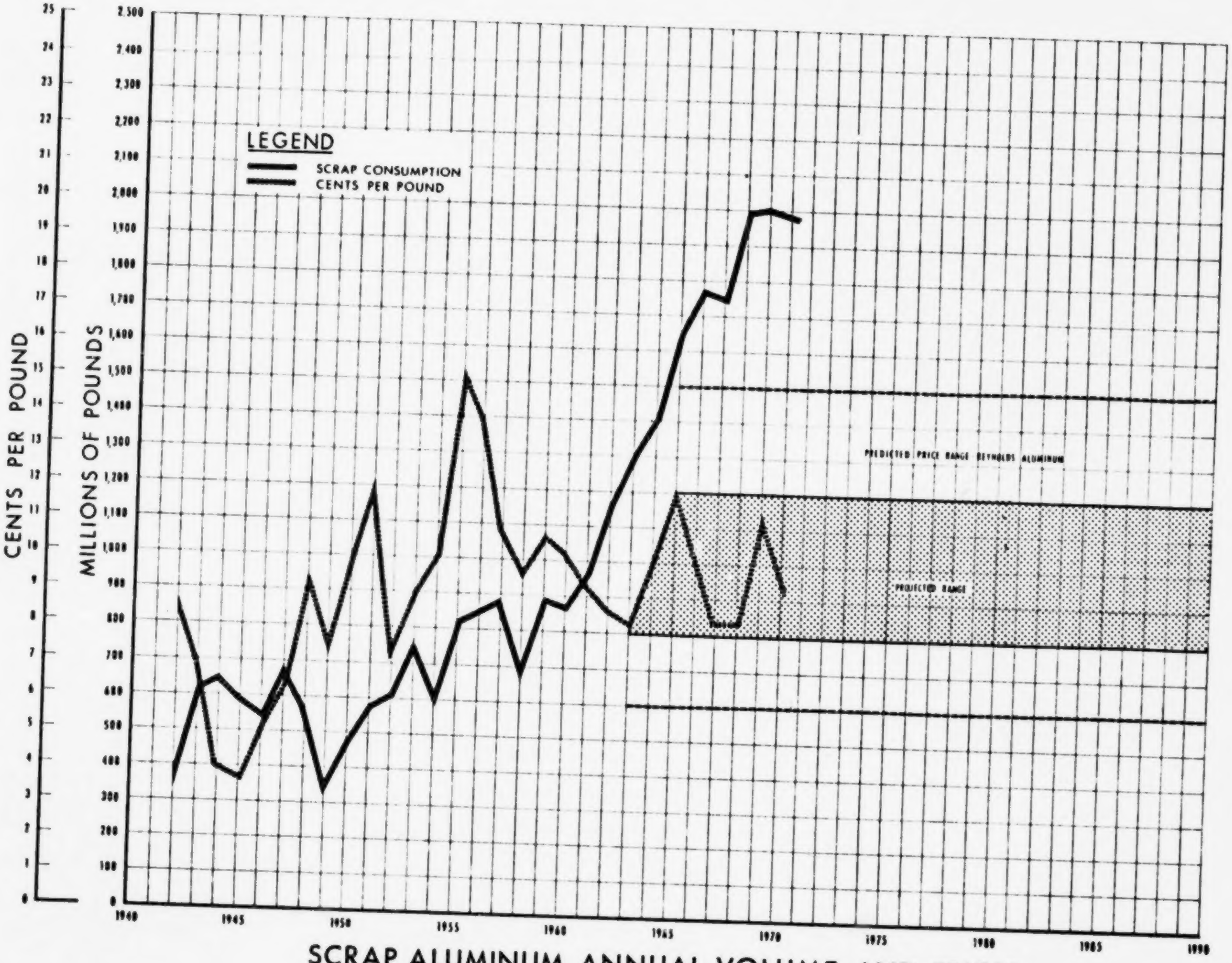
Bethlehem Steel spokesman believed at that time that the tin and copper content in the recovered ferrous were not a major problem. They had observed from experience that the slow build up of these materials caused by recycling the contaminated home scrap would level off before dangerously high levels of contamination were reached. One technical spokesman suggested that use of the Town's scrap at the level of 10% of their total purchased scrap would probably not cause any appreciable build-up.

Written confirmation of these statements was not received. Instead, their January 1972 letter stated that "Bethlehem does not consider ... [the recovered ferrous] an acceptable steelmaking material and can make no commitment to accommodate any fixed tonnage from any particular source."

The United States Steel Corporation cooperated in the study but responded that the ferrous residue was not as saleable as tin cans recovered by front-end separation. The company referred to the material as "incinerator bundles" and presently purchases unincinerated tin can scrap at the price for #2 bundles in accordance with their specification. The company wrote, in support of its position regarding residue ferrous, that copper cannot be eliminated, ranging in levels from 0.2 to 0.5%. The firm felt that since some popular grades of steel specify a minimum of 0.06% copper, and since present copper residual levels are ranging from 0.01 to 0.12%, another "uncontrolled" source of copper-bearing scrap was to be avoided.

5.2 Non-ferrous

Marketing of the non-ferrous material was investigated from the viewpoint of selling the mixed non-ferrous without further segregation; the light fraction, primarily aluminum, separately; the mixed heavy fraction, primarily copper, zinc and lead, separately, unsorted; and/or the mixed heavy fraction further sorted into the major individual components, each marketed separately.



SCRAP ALUMINUM ANNUAL VOLUME AND PRICES
1942 TO 1970 AND PROJECTED 1971 TO 1990

FIGURE 5-3

5.2.1 Aluminum

a. Utilization of Aluminum Scrap

During the past 20 years, the price for cast aluminum scrap has oscillated between 7 cents and 15 cents per pound, dropping to 7 cents in 1971 and averaging 10 cents per pound ($202/ton) over the twenty year period. Figure 5-3 illustrates these fluctuations and the predicted future price range of 6 to 15 cents per pound.

Expert opinion has priced the aluminum extracted from North Hempstead's residue at 2 cents under the current market for cast and sheet, the reduction in price resulting from the material's impurity. There are numerous small processors of aluminum scrap, leaving no question as to the marketability of the material from the residue.

b. Markets for Aluminum Residue

Reynolds Metal Co. has expressed an interest in the light fraction of our non-ferrous as aluminum if the non-ferrous is separated into light and heavy fractions. This firm has provided specifications that our material would be required to meet. Experimental programs conducted by Reynolds in reclaiming aluminum from non-ferrous material supplied by the Bureau of Mines have resulted in recovered material that does fall within the firm's general specifications. The firm has cautioned that their work thus far is of laboratory scale only and that full-scale vertification will be required to verify the compositions they found in the Bureau of Mines' sample. By their analysis, the larger screen fraction had the following composition, in addition to aluminum:

Reynold's Metal Company Analysis of Bureau of Mines' Non-Ferrous
-1-1/4" +20 mesh

% Si	1.5
% Fe	.9
% Cu	.5
% Mn	.1
% Mg	<.05
% Cr	<.05
% Ni	<.05
% Zn	.3
% Ti	<.05
% Pb	.1
% Bi	<.05
% Sn	<.05

Summary

Advisory Materials Standards for
Recovered Aluminum from Incinerator Residue
Reynolds Metal Company

1. Aluminum must be separated from all other materials.
2. If processed dry following incineration, aluminum must be baled to 30 pcf minimum density.
3. If processed wet following incineration, aluminum must be shredded or dried prior to baling.

4. Shredded material must pass over 12 mesh screen to reduce fines. Fines (dust, dirt, sand, paint, etc) must not exceed 3% of gross weight.

5. The minimum contamination follows:

Iron	1%
Zinc	1%
Copper	1%
Lead	0.3%
Tin	0.3%
Nickel	0.3%
Bismuth	0.3%
Chrome	0.3%
Manganese	1%
Magnesium	1%
Silicon	Variable under 5% (expected to be 0.5% or less)
Balance Aluminum	

According to Reynolds Metal, the price would be a function of the preparation of the material, the alloy combinations and market conditions.

5.2.2 Heavy Non-ferrous

The heavy non-ferrous is recovered in two separate fractions: coarse (plus 4 mesh) and fines (minus 4, plus 20 mesh). The major components are copper, zinc and lead. The percent composition can be expected to be about 50-58% copper, 35-36% zinc and 4-6% lead, with varying minor amounts of aluminum, iron and steel, tin, magnesium, manganese and silicon. Table 6-1 gives an approximation of expected composition. Although the individual constituents, particularly copper, are ordinarily of significant value, the mixture, particularly with any iron and steel contamination, is of low market value.

Assays from the final recovery plant at North Hempstead are expected to be an improvement from those presently available.

Since both fractions of the heavy non-ferrous must be generated as a result of aluminum separation, a selling price, however low, is assumed, rather than send the processed material to landfill. The price, like that for aluminum, is f.o.b. North Hempstead. The valuable components may result in the shipment of this material overseas.

5.3 Glass

5.3.1 Utilization of Waste Glass

Although glass constitutes one of the most significant materials in municipal solid waste, its recovery from the waste stream is extremely low. Glass comprises 8% of the raw refuse nationally and accounts for 37% of incinerator residue at the Hempstead Harbor refuse processing plant. There is no recent literature or statistical source giving the percentage of waste glass which is returned for reprocessing from municipal disposal systems. It has been estimated at less than one percent.

It is surprising that glass cullet is not recycled from municipal waste, when its desirability in the primary manufacture of glass is well established. The glass industry utilizes cullet routinely at a level of at least ten percent of input weight, but this cullet is comparable to the "hone scrap" of the steel industry and is generated at the manufacturing plant either as a waste product or as deliverately produced cullet. The glass cullet aids the glass making process by both lowering the melting temperature and speeding up the melting process. This, in turn, extends the life of furnace linings, reduces fuel requirements and increases the production rate. Cullet is also desirable because it tends to increase molten glass viscosity. There are occasions when 100% cullet is used in glass production. Up to 30% cullet could regularly be used in glass container production, glass container manufacture being by far the largest segment of the glass industry and accounting for 90% of the glass in municipal waste. Facilities to handle cullet require relatively little capital investment.

Glass manufacturers, however, prefer cullet which is generated within the plant, where its composition is assured. The manufacturer will generally deliverately produce excess cullet in slack periods for later use, rather than utilize waste cullet recycled, in the true sense, from the consumer. The use of purchased cullet, referred to as "foreign" or "tramp" cullet, has declined for several additional reasons.

Cullet dealers have declined because of the decline of returnable containers, formerly turned to high quality cullet if rejected after the bottle washing operation. Further, there is relatively less flint glass and more amber and green glass, less desirable for recycling. Handling costs have resulted in a decline of the number of bottling plants interested in returning rejects to dealers. Dealers are thereby forced to pick up some glass at no charge. A major factor in decline of cullet dealers is that dealer's collection, delivery and processing costs have also risen because of the high proportion of labor involved. Capital is not available for modernization of dealer's processing facilities or enlarging the scope of their operations.

In addition to dealer decline, low virgin raw material costs in glass manufacture contribute to the industry trend toward utilizing less and less purchased scrap.

Although the Glass Container Manufacturers Institute (GCMI) publishes such impressive statistics as "25,500 tons of waste glass" were recovered by their public collections centers during the first six months of the 1970 program, this amounts to a fraction of 1% of the annual waste cullet generated.

Present utilization of waste glass in primary glass manufacture' can be seen to represent an insignificant aspect of the industry as a whole. When secondary uses of waste glass cullet are considered, it is found that there is little established industry activity in the past, but a few promising developments for glass utilization where cullet quality control is less critical.

One of the most promising of the potential industries is the manufacture of glasphalt, a paving aggregate in which glass is substituted for crushed limestone, developed at the University of Missouri - Rolla. This development is funded by the U. S. Environmental Protection Agency and GCMI. Prior to March 1972, the University and manufacturers, civic groups and municipalities placed experimental and demonstration glasphalt pavements in eighteen separate useful locations in the U. S. and Canada, ranging in material usage from three tons to 1,450 tons.

Other secondary uses of cullet are discussed in greater detail under the specific marketing investigations, where the significant new developments are covered.

5.3.2 Markets for Residue Glass in Glass Production

The best potential market for the glass fraction recovered from residue is in the manufacture of amber glass, utilizing the recovered clear glass, only. Four glass manufacturers became involved in the evaluation of the marketability of the clear glass primarily due to the cooperation of the Glass Container Manufacturers Institute. These were Anchor Hocking Corporation, Metro Containers div. Kraftco Corporation, Owens - Illinois and Thatcher Glass Manufacturing Company. Of these all of the last three companies made firm commitments for future residue glass consumption.

Anchor Hocking Corporation's plant at Connellsville, Penna., performed test runs this year utilizing over seven tons of glass recovered from residue by the Bureau of Mines pilot plant. The tests, incorporating five percent reclaimed glass, along with normal raw material, were the first time incinerator residue had been used successfully in this country in commercial manufacture of new bottles. The tests were successful in that amber glass containers were made without difficulty in the melting, forming or annealing processes. The finished containers showed no loss of strength or ductility. Aluminum or other reducing agents in the residue, however, acted as contaminants and caused visual flaws, or seeds, in excess of the manufacturer's standards. Anchor Hocking Corporation wrote expressing interest in using waste glass recycled from incinerator residue at any of their plants producing amber glass if the contaminants are removed or reduced to acceptable levels. The nearest Anchor Hocking plant is in Salem, New Jersey.

In January 1972, segregated samples of clear and colored glass recovered by the Bureau of Mines from the second North Hempstead sample were sent to Anchor Hocking for studies of its use as cullet in the glass batch. As this report went to press, Anchor Hocking would not, however, make a written expression in any definite material quantity, or in any given price and appears to have no definite interest in accepting the material.

Metro Glass Div. Krafco Corp. ran an analysis of a sample of clear glass sent to them from the first North Hempstead sample. The contaminants which Metro Glass found were:

Aluminum	2.75%
Carbonaceous Material	2%
Fe	0.5%
Cr	.025%
Other	.1%

TABLE 5-1

ANALYSIS OF CLEAR GLASS CULLET RECOVERED FROM NORTH HEMPSTEAD INCINERATOR RESIDUE*

by: Owens-Illinois, Inc.

CHEMICAL ANALYSIS

CONSTITUENT	SYMBOL	PERCENT
Silica	SiO_2	72.6
Alumina	Al_2O_3	2.35
Iron	Fe_2O_3	0.22
Titania	TiO_2	0.14
Calcia	CaO	9.14
Magnesia	MgO	1.59
Barium Oxide	BaO	0.14
Sodium Oxide	Na_2O	13.6
Potassium Oxide	K_2O	0.4
	Cr_2O_3	0.029
	CuO	0.006
	PbO	0.044
	MnO	0.025
Sulfide		0.005
Total		100.-

SIEVE ANALYSIS

Mesh No.	% on Sieve
+30	4.2
+40	12.1
+50	20.7
+70	19.7
+100	16.2
+140	13.6
+200	8.8
Pan	4.7

REFRACTORY ANALYSIS

	Number of Corundum Particles per Pound of Sample	
Mesh No.	+3.3 sp. gr. Separation	+2.75 sp. gr. Separation
+40	6	14
+60	41	50

*From second sample

Metro Glass found this analysis unacceptable, noting that the sample would produce dark, opaque glass only. Of the critical contaminants, the firm noted, the aluminum level of 2.75% would have to be reduced to 0.1% to be acceptable. At this aluminum level, the other contaminants would take care of themselves, according to Metro. They also noted that small amounts of carbon and iron would be acceptable in amber glass. While Metro had not yet completed testing on the second run sample, the firm noted a definite improvement over the first sample.

Metro Containers subsequently confirmed in writing that they would be willing to purchase 6 TPD of the cullet, at a price of $15.00 per ton delivered to their Jersey City plant. The purchase commitment was made with the understanding that the cullet must equal or surpass the quality of the latest sample. The firm promised to provide precise specifications at a later date.

Metro states that they are committed to the concept of recycling, and receives recovered cullet from several voluntary programs, somewhat less than 5% of their raw material is from such programs. Their nearest plants are in Jersey City and Carteret, New Jersey.

Owens-Illinois, which has nearby plants in Bridgeton and North Bergen, New Jersey, expressed interest and received samples of glass recovered by the Bureau of Mines from the second North Hempstead sample. The samples included the clear glass fraction, colored glass fraction and unseparated glass. Until this time the firm had devoted its recycling efforts to unincinerated solid waste, because the quantities involved were larger. The firm found that North Hempstead's sample of colorless cullet did not meet their specifications for use in primary glass manufacture.

After completing an analysis of the clear glass sample, Owens-Illinois replied that it was acceptable in all ways except for refractory particles. The firm wrote in confirmation that if the material were available today and within the required refractory specification, they would be willing to purchase six tons per day at $12.00 per ton delivered to their North Bergen, New Jersey, plant. The company expects that this purchase price will not decrease significantly in the near future.

Owens-Illinois would plan to utilize this material experimentally in their color furnace at the North Bergen plant for a two year test period. This experimental program would consist of introducing ever-increasing percentages of this material to the tanks beginning at the 1% level in order to establish the necessary criteria for further utilization of the larger quantities that, the firm notes, would in all probability develop if other incinerator residue reclamation programs are constructed throughout the nation.

Owens-Illinois detailed a refractory particle specification of not more than 2 particles greater than 40 mesh in size and not more than 20 particles in size range -40 +60 mesh on a one pound sample. Their refractory particle analysis, seive analysis and chemical analysis appear on Table 5-1.

TABLE 5-2

ANALYSIS OF CLEAR GLASS CULLET RECOVERED FROM NORTH HEMPSTEAD INCINERATOR RESIDUE*

by: Thatcher Glass Company

This analysis to also serve as minimum specification for purchases by Thatcher Glass.

CHEMICAL ANALYSIS

CONSTITUENT	SYMBOL	PERCENT
Silica	SiO_2	72.75
Alumina	Al_2O_3	2.11
Iron	Fe_2O_3	.175
Calcia	CaO	9.18
Magnesia	MgO	1.66
Barium Oxide	BaO	.12
Sodium Oxide	Na_2O	13.26
Potassium Oxide	K_2O	.53
Boric Oxide	B_2O_3	
Sulphur Trioxide	SO_3	
Fluorine	F_2	
Arsenic Pentoxide	As_2O_5	
Titania	TiO_2	.082
Zirconia	ZrO_2	
	Cr_2O_3	.011
	MnO	.035
Total		99.92

SIEVE ANALYSIS

Sieve No.	Sieve Specs.	Percent on Sieve
10	Max.	-
14	Max.	-
20	Max.	-
28	Max.	4.3
35	Max.	4.7
45		29.3
65		21.1
100	Min.	17.2
150		13.1
200		6.5
Pan	Max.	3.0

*From second sample

Thatcher Glass Company, with plants in Big Flats, New York, and Wharton, New Jersey, also studied the clear, colored and unseparated fractions from the second North Hempstead sample. As a result of their analysis and interest in the project, Thatcher Glass confirmed in writing that the company is prepared to commit for purchase of up to six tons per day of the clear glass fraction for a period of two years from the inception of the Hempstead Harbor facility modeled after the Bureau of Mines separation system which they understand, includes flotation, water jigging and high intensity magnetic separation incinerator. The glass is to be used in making new glass containers on an experimental basis.

The firm requires that the quality of the glass cullet be equal to or better than the samples submitted as defined by the analytical results which the firm performed on the samples. These results appear as Table 5-2. Thatcher Glass quoted a price of $15.00 per ton delivered, and specified purchase and delivery terms. Delivery via truckload will be accepted at the plant at Wharton, New Jersey, Monday through Friday between the hours of 8 a.m. and 4 p.m. The trucks must be weighed prior to delivery at the shipper's expense and the certified scale ticket used for invoicing and payment.

5.3.3 Markets for Residue Glass in Building Product Manufacture

Both the clear and colored glass fractions, or the unseparated recovered glass could be used in the manufacture of building products, but specific markets have not yet been established. Since a feasible market for clear glass is expected in the primary manufacture of glass containers, the investigators concentrated their efforts in the less discriminating, secondary field into locating a market for the lower-valued colored fraction. Among the building products with potential, are insulation materials such as the Bureau of Mines foam insulation, brick, light weight aggregate, tiles, and wall panels. Certain of these materials, such as tile, have applications requiring no color separation and so could use either the colored or unseparated cullet in addition to the clear fraction. Discussion of the potential use as aggregate is under "Markets for Residue Glass in Heavy Construction Materials" except where very specifically applicable to building materials.

The Glass Container Manufacturers Institute has received samples of clear and colored glass from the second sample, in addition to unseparated residue glass from the first sample and is studying the feasibility of utilizing the materials in the secondary materials industry, expecting that the economies in primary glass manufacture will be negative. One building product revealed by the Institute is a tile involving 50% waste glass cullet.

Certain-Teed Products Corporation announced plans to invest in producing brick, blocks and other building products using a process developed by their Tekology Corp. of Palisades Park. Aggregates used by Tekology are "inert sterile granules from garbage treated by a high-temperature incinerator" which, according to James Ryan, Tekology's president, make "an ideal material for bricks." The process involves no heat and calls for mixing of aggregate, cement, water, and chemicals for the purpose of binding, followed by molding of the bricks under high pressure. Crushed glass recycled from non-returnable bottles was also used in the process to successfully make glass building bricks meeting the ASTM severe weather standard.

Certain-Teed stated they are familiar with the Bureau of Mines system of residue recovery and has made bricks using their residual sand and glass. The company has written that their concept for using the glass and sand from the residue recovery facility would be to construct a Tekology style plant at the residue plant. The Tekology plant might be financed by one of three possibilities according to Certain-Teed:

1. The plant might be constructed by the municipality under the Certain-Teed license.

2. The plant might be constructed as a joint venture between the municipality and Certain-Teed.

3. Certain-Teed might construct and operate the plant and market the product.

Certain-Teed believes there is a market in the metropolitan area for their bricks. The most economical plant size would require 60,000 tons of residue per year, or a daily average of 165 tons per day. The company ventured the opinion that the residue raw material might be valued at the local cost of sand or other aggregates.

Certain-Teed did not offer information as to the competitive price posture of Tekology building materials versus conventional products, nor as to its sales potential and basic marketability.

Research work at University of Missouri - Rolla is presently being conducted where structural elements are extruded under high pressure from a mixture of waste plastic and finely ground glass in the size range of the glass recovered from the North Hempstead incinerator residue.

5.3.4 Residue Glass in Heavy Construction Materials

The quality of residue glass for manufacture of secondary building products and glass for heavy construction materials is less than that for the primary manufacture of glass. Therefore uses for colored glass, which is difficult to market as cullet for glass manufacture, were sought in the heavy construction field. Again, any markets in this domain for the colored fraction can be expected to apply to the higher-valued clear glass fraction or to the unseparated mixture of clear and colored. Heavy construction products which offer plausible markets for residue glass in their manufacture include asphalt pavement, limestone dust and slurry seal coat.

Dr. Ward Malisch of the University of Missouri - Rolla performed studies of samples from the second clear and colored samples and the first sample of unseparated residue glass to determine specific properties and assist in recommending potential uses as a paving aggregate. Table 5-3 lists the gradation, specific gravity and unit weights determined by Dr. Malisch.

Dr. Malisch observed that the recovered material would have to be blended with a coarser material if it were to be used as a paving aggregate. The blend of coarser material, probably a crushed stone or gravel

TABLE 5-3

ANALYSIS BY UNIVERSITY OF MISSOURI - ROLLA OF GLASS RECOVERED FROM NORTH HEMPSTEAD INCINERATOR

Dr. Ward R. Malisch

Sieve Analysis

Sieve	Percent Passing		
	Clear	Colored	Mixed
No. 8	100	100	100
No. 16	100	100	100
No. 30	96	95	98
No. 50	75	75	82
No. 100	36	35	48
No. 200	13	14	25

	Bulk Unit Weight (pcf)	Apparent Specific Gravity
Clear	82.5	2.50
Colored	100.0	3.20

and a coarse sand, would depend upon its gradation. He thought that up to 30% of the residue material could be used in an asphalt mixture, but that any greater proportion would result in excessive amounts of material passing the No. 50 sieve. He noted that if any minus 50 material were present in the coarse aggregate, the residue proportion would have to be reduced to less than 30%.

Because of the unusually fine particle size, the university could not separate the non-glass components and therefore had difficulty predicting the suitability of this material for use in a paving product with which the civil engineering department was experimenting, known as "glasphalt." It was therefore necessary to actually substitute some of the residue for the clean glass ordinarily used in glasphalt and evaluate the suitability of the residue by seeing its actual performance. Results have not been received.

5.3.5 Markets for Residue Glass in Miscellaneous Secondary Manufacture

Other than building and heavy construction products, the secondary use of recovered cullet from incinerator residue appears to be limited. A market in the manufacture of glass beads may exist with the firm of Potters Industries, Inc. in Carlstadt, New Jersey. No color separation is required for this product, permitting the use of the colored fraction here.

5.4 Sand and Ash

5.4.1 Markets for Residue Sand

The Certain-Teed controlled process discussed earlier offers the same potential for marketing the sand recovered from incinerator residue as it does for the glass fraction. For utilization in this process of brick manufacture, either or both sand and glass would be sold at the local price for sand. The recovery process would be simplified and reduced in cost if it was decided not to market the clear glass in primary glass manufacture and, instead, combine all the glass with the sand, for sale in the less discriminating secondary manufacture of building products.

The sand recovered from incinerator residue has some potential for use by the Town of North Hempstead itself as a fine aggregate for pavement. Tests are planned by the Town's Department of Highways.

In almost all cases, the ready availability of natural aggregates, with known composition and workability, tends to severly limit the potential for marketing this component of incineration residue.

5.4.2 Markets for Ash

Ash constitutes about 10% of the residue makeup if siftings and residue are combined. In comparison to the lack of research and experience in the utilization of residue components, an appreciable background of information has been accumulated in the United States on flyash utilization. There is no available data on the properties and potential users of North Hempstead's ash material, however, and its composition would be expected to differ substantially from that of incinerator or power plant flyash. No return is expected from the sale of either ash or ash and flyash combined, although some use as a filler might be expected.

5.5 Transportation Costs for Recovered Residue

5.5.1 Ferrous

The most economical means of transportation of ferrous residue is rail shipment from North Hempstead to users in the West Virginia-Pennsylvania-Ohio steel-making industry. The material fits the classification of "scrap iron and steel for remelting purposes" and the rate is in dollars per gross ton. Either the Roslyn or Queens Village rail sidings can be used, but rate-of-return figures in this report are based on shipment from the nearer Roslyn siding, because of hauling factors. The Roslyn rate is about 6-1/2% higher than that from Queens Village. Train freight rates to Weirton, West Virginia, from both locations are in Table 5-4. The tabulated rate bases show that small shipments are not economical. Shipments of less than 44,800 lbs. are charged for the full 44,800 lbs. Between 44,800 lbs. and 80,000 lbs. the rate is $20.01 per gross ton. The rate decreases to $18.37 per gross ton when 80,000 lbs. are reached and there are further rate decreases for larger shipments.

According to LIRR information, prudent shipping schedules will be needed to adjust gross weight to the best rate. Note that between 66,938 and 80,000 lb. the difference of 13,062 lb. is free of charge (Table 5-5). Over 112,000 lbs. the rate is $15.41 per gross ton, or $13.75 per net ton, from Roslyn.

Multiple car shipments will further increase the economy of rail freight handling. The Long Island Rail Road Company is willing to sponsor and support a proposal for a reduced rate of $12.25 per gross ton for multiple car shipments of the recovered ferrous scrap in briquette form from Roslyn to Wierton, subject to future general freight rate increases. The minimum weight requirements will be 500 gross tons per shipment in not more than ten cars and subject to the usual multiple car conditions. The number of freight cars required to accomodate the 500 ton shipment will be made available as a unit subject to 48 hours free time for loading beginning with the first 7 a.m. after placement. After expiration of the free time, normal demurrage charges are $10 per car per day during the first four days, $20 per car per day for the next two days, and $30 per car per day thereafter.

The multiple car shipment rate contributes significantly to a profitable return on the sale of ferrous metal. Since the conditions to obtain the favorable rate can be met, this rate, which amounts to $10.94 per net ton, is used in this report to predict the net income from recovered ferrous.

5.5.2 Non-ferrous

Aluminum and mixed heavy non-ferrous are best sold and shipped separately. The selling price of aluminum was obtained f.o.b. North Hempstead, and the transportation cost is absorbed into the adjustment in selling price for the locality. The material would be shipped via truck.

TABLE 5-4

TRAIN FREIGHT RATE TO WEIRTON, WEST VIRGINIA
FOR SCRAP IRON AND STEEL FOR REMELTING PURPOSES
SINGLE CAR SHIPMENTS

Minimum Weight of Single Car Shipment			Dollars Per Gross Ton		Dollars Per Net Ton	
			Shipment From		Shipment From	
Lbs	Gross Ton	Net Ton	Roslyn	Queens Village	Roslyn	Queens Village
44,800	20.0	22.4	22.01	20.98	19.66	18.74
80,000	35.7	40.0	18.37	18.40	16.40	16.42
112,000	50.0	56.0	15.41	13.90	13.75	12.42

TABLE 5-5

FREIGHT RATE CHARGED

FROM

ROSLYN, N.Y. TO WEIRTON, W. VA.

SINGLE CAR SHIPMENTS

Weight (Lbs)	Rate Charged ($/Net Ton)	Amount Charged for (Lbs)	Total Charged ($/Shipment)
0 to 44,800	$ 19.66	44,800	$ 440
44,800 to 66,938	19.66	44,800 to 66,938	440 to 656
66,938	19.66	66,938	656
66,939 to 80,000	16.40	80,000	656
80,000 to 93,902	16.40	80,000 to 93,902	656 to 770
93,902	16.40	93,902	770
93,903 to 112,000	13.75	112,000	770
112,000 to 125,000	13.75	112,000 to 125,000	770 to 859

The mixed heavy non-ferrous might be sold within the metropolitan area, favorable factor in its marketability.

5.5.3 Glass

The freight rate for recovered glass depends on whether the railroad classifies it as crushed glass or sand. If classified as "Bulk Sand" the rate is approximately one-half that for crushed glass, "Broken, ground or pulverized glass," via Long Island Railroad. Rates to the Owens-Illinois plant in North Bergen, New Jersey, from Roslyn are 24¢ per 100 pounds for bulk sand and 55¢ per 100 pounds for broken, ground or pulverized glass. Minimums of 80,000 pounds of sand and 40,000 pounds of glass are required.

Trucking is feasible if the recovered glass is marketed in or near the greater metropolitan area. If a shipping radius of approximately 30 miles is maintained, it is possible to use an hourly-rented truck and make two round trips per day, at about three hours per trip including loading and unloading. At a rental of $25.00 per hour, or $75 per trip, a 20 ton truck will give a transportation cost of approximately $3.75 per ton. Truck rental on a per-trip basis is necessary for the more distant location and its economics hinges on making, on an average, one out of two trips both ways with a full truck. If a truck could make all trips full both ways, the rate would drop to $4.00 per ton.

The trucking costs are summarized on Table 10-1.

CHAPTER 6

RESIDUE RECOVERY FACILITY INVESTIGATIONS

6.1 General

Very little work has been done in the field of residue recovery. Progress was made in analyzing and predicting residue constituents through the research of such workers as Kaiser[1] and Schoenberger[2] and such background served as a useful comparison with the results of composition tests performed under this study.

Few of the solid waste recovery systems presently being developed[3] relate to combustion processes. The Combustion Power Company of Palo Alto, California has reached the pilot plant stage in the development of its CPU-400 system of incineration, salvage of metals and glass, and power generation, supported by the U.S. Public Health Service. High temperature incineration systems involving slag recovery are in the pilot plant stage with three firms: The Sira Corporation, Los Gatos, California; Dravo Corporation, Pittsburgh, Pennsylvania; and Carborundum Company, Erie, Pennsylvania. Pyrolysis processes involving recovery of final by-products such as charcoal have reached the pilot plant stage with Pan American Resources, Albuquerque, New Mexico and a more advanced stage with a 50 tpd Monsanto plant at St. Louis, Missouri. Union Carbide Corporation has also recently announced a pilot plant high temperature system in Tarrytown, New York.

Considerable research and plant experience has been gathered in the flyash utilization field. An excellent discussion of the utilization of flyash as a concrete additive, soil stabilizer, soil conditioner, absorbent in water and waste water treatment, lightweight aggregate and basis for bricks is included in the U.S. Environmental Protection Agency (EPA) publication, Recovery and Utilization of Municipal Solid Waste.[4]

The same EPA publication[5] lists thirteen municipal incinerators practicing metal salvage in 1968. The salvaged material, tin cans, is used for precipitation iron in the benefication of copper ore, as a tin source in detinning operations, and as steel scrap for steelmaking. The largest use of the three is in copper benefication, Proler Steel Company being the major broker, buying the material at a price of $10 to $20 per ton.

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[1] Kaiser, E.R., Zeit, C.D. and McCaffery. "Municipal Incinerator Refuse and Residue". 1968

[2] Schoenberger, Robert J., Purdom, Paul W. "Residue Characterization". Journal of the Sanitary Engineering Division, Proceedings ASCE. June 1969.

[3] Cheney, P. L., Glass Container Manufacturer's Institute. Testimony before the Senate Subcommittee on Air and Water Pollution for the Resource Recovery Act of 1969. Mar. 31, 1970

[4] Drobny, N.L., Hull, H.E. and Testing, R.F. Recovery and Utilization of Municipal Solid Waste, U.S. Environmental Protection Agency and Battele Memorial Institute, 1971 pp 83-86

[5] Ibid., pp 86-87

The next three sections of this chapter deal with the only significant developments to date in the specific field of residue recovery: first, and primarily, the work of the U. S. Bureau of Mines, and then the experimental work of National Steel and the Williams Patent Crusher and Pulverizer Co.

6.2 Bureau of Mines

The U. S. Bureau of Mines has developed and demonstrated a technically feasible method of processing incinerator residues to reclaim metal and mineral values. This "mining of urban ore" utilizes a system of proven mineral engineering equipment to shred, screen, grind and magnetically separate components of residue.

The first processing step consists of screening in a punched plate trommel screen having 1-1/4 inch holes. An inclined belt conveyor with enclosed sides feeds the trommel. The minus 1-1/4-inch material is screened and washed on a 30-inch-diameter circular vibrating screen fitted with both 4- and 20-mesh screens. During screening the residue materials are sprayed continuously with water. Bulk, organics and other items that can not be handled by equipment of the pilot plant size are picked off by hand near the beginning of the process.

The plus 1-1/4-inch material is blended with the minus 1-1/4-inch plus 4-mesh fraction from the primary screening operation then shredded in a 30-hp hammermill. The minus 4-plus 20-mesh fraction from the primary screening operation is joined with the shredded material, and is transferred to a 30-inch-diameter secondary vibrating screen fitted with both 4- and 20-mesh screens. The plus 4-mesh oversize material is discharged to a vibrating conveyor which spreads the material and underfeeds a permanent magnet drum-type separator. A water spray gives the material adhering to the magnet a final wash, leaving a clean iron product. To recover the non-ferrous metals, the remaining fraction is fed to a 10-hp hammermill. The hammermill discharge is screened and washed on a 24-inch-diameter circular vibrating screen fitted with both 4- and 20-mesh screens. The plus 4-mesh material is recovered as a non-ferrous metal concentrate. The minus 4-plus 20-mesh fraction is treated by an electrodrum magnetic separator using an overfeed system. The magnetic material is collected after a water spray directed on the drum face washes away nonmagnetic material, which is dewatered to about 60 percent solids in a spiral-type classifer. This pulp is ground in a peripheral discharge rodmill. The rodmill discharge is washed and screened on a 20-mesh, 24-inch-diameter circular vibrating screen to recover a non-ferrous metal product.

The non-ferrous end products, coarse and fine, further subdivided into "heavies" and aluminum, were obtained by processing the residue of various municipal incinerators through the system on different occasions and these end products analyzed. North Hempstead's end products were never analyzed. Therefore Table 6-1, "Typical Compositions of Non-ferrous Metal Products Reclaimed in the Bureau of Mines Incinerator Residue Recovery Plant," should be referred to when it is desired to know a reasonable approximation of the makeup of the actual non-ferrous end products. It represents the present capability of the College Park plant for non-ferrous recovery.

TABLE 6-1

TYPICAL COMPOSITIONS OF NONFERROUS METAL PRODUCTS RECLAIMED IN THE BUREAU OF MINES INCINERATOR RESIDUE RECOVERY PILOT PLANT

PRODUCT	PERCENT COMPOSITION								
	Al	Cu	Zn	Fe	Pb	Sn	Mg	Mn	Si
Coarse composite (Plus 4-mesh)	59.4	16.8	16.4	2.86	5.1	-	0.04	0.30	0.77
Aluminum	Bal.	0.16	0.03	1.3	0.12	0.012	0.38	0.30	0.15
Heavies	0.25	58.9	35.8	0.10	4.3	0.22	-	-	-
Fines composite (Minus 4, plus 20-mesh)	65.1	18.4	8.9	4.3	2.6	0.7	0.002	-	-
Aluminum	Bal.	0.43	0.24	0.83	0.43	0.03	0.02	0.41	0.30
Heavies *	2.44	50.65	35.85	0.30	5.54	1.19	-	-	-

* Ni - 0.50%

The minus 20-mesh material is pumped to a 26-inch-diameter by 1-inch thick rotating disk, matrix-type magnetic separator where the glass content is given a rough magnetic cleaning in a 3,000 gauss field to remove highly magnetic particles. A final magnetic cleaning of this rougher nonmagnetic concentrate is made in a commercial high-intensity magnetic separator with a field strength of 24,000 gauss, producing a product that is primarily colorless flint glass.

All minus 20-mesh products from the various screening operations and waste waters are combined at the water reclaimation system. Here they are classified in a spiral classifier to remove slimes. Sodium Carbonate and Ferrous Sulfate are added. The slime is then flocculated and thickened in a thickener. The overflow is filtered on a vacuum drum filter leaving a clean overflow to be recycled as wash water.

Fresh water is introduced into the processing system at two locations: the rod mill and the matrix magnetic separator. The water, which is relatively clean, is discharged to the sewer, because the pilot plant installation is too small to warrant water reuse.

Tests of the residue from various incinerators were conducted by the U. S. Bureau of Mines to ascertain the degree to which this residue could be recovered in a Bureau of Mines type of system. Additional tests are still underway. Materials recovered include ferrous metal, aluminum, brass, copper and clear and colored glass. Studies based on the 1000 lb. per hour pilot plant operated by the Bureau of Mines in College Park, Maryland have determined that the value of these materials can be as much as $15 per ton of residue.

This plant has served as a pilot plant for the prototype proposed on a larger scale for North Hempstead.

6.3 Investigation of National Steel Utilization of Chicago Municipal Incinerator Residue

Representatives of the Environmental Protection Agency, the Town of North Hempstead, James Flett Organization and Leonard S. Wegman Co. Inc. visited the National Steel Plant in Weirton, West Virginia in February 1972 to explore ferrous marketing prospects for the residue recovered from the North Hempstead incinerator in the applications to steelmaking developed by National for Chicago's residue. Many of the insights gained from this meeting and other exchanges with National Steel have been significant to the completion of this study. The practical information gained from National on marketability and material standards and preparation is included in Chapter 5, "Marketing Investigations."

In a paper summarizing National Steels' recent research in the recycling of incinerator residue, E.J. Ostrowsky[1] discusses the various implications for residual buildup as a result of BOP and blast furnace usage of incinerator residue. The effect of residuals such as tin, copper and nickel is considered where incinerator scrap is used in the BOP process and a discussion included of the build up of these residuals in the system as a result of recycling the home scrap. He calculates that ingot residuals would stabilize after seven months and presents graphically the final residual level for incinerator scrap varying continuously from 0 tons to 50 tons per 300 ton BOF heat. At 5% incinerator scrap, or 15 tons, the residuals are 0.03% Cu, 0.01% Sn, and under 0.01% Ni. No other residuals are considered in the illustration. Ostrowsky also discusses residuals resulting from blast furnace usage of incinerator residue, although not based on actual tests.

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[1] Ostrowsky, E. J., "Recycling of Tin Free Steel Cans, Tin Cans and Scrap from Municipal Incinerator Residue." National Steel Corporation. Prepared for presentation at 79th General Meeting of American Iron and Steel Institute in New York, 1971, 33 pp.

Among his conclusions Ostrowsky notes that since current scrap requirements in steelmaking are in equilibrium, increased scrap production will have to result in scrap usage in the blast furnace process or additional electric furnace capacity. He concludes that "the recycling of . . . incinerator residue has been demonstrated, with quantities limited to meet process and product chemistry requirements," and that future usage of incinerator residue will have to be also limited because of equivalent process and product restrictions.

Ostrowsky also points out in the same paper that to use incinerator scrap in the blast furnace, its density will have to be equal to ore materials of from 100 to 140 pcf. and the scrap bale limited to a size that will pass through furnace charging equipment. He explains that high density material is necessary because of strained blast furnace filling capacities and the possibility of entrainment of lightweight scrap in the off gases.

6.4 Tests and Demonstrations by the Williams Patent Crusher and Pulverizer Company

In December 1971, the Leonard S. Wegman Co. Inc. observed a series of tests and demonstrations of specific incinerator residue separation and processing programs developed by the Williams Patent Crusher and Pulverizer Co. of St. Louis, Mo. It was of interest to determine whether the Williams' shredder and separation equipment could produce products similar to those obtained from the Bureau of Mines system. Williams had developed a system to reclaim vital components from junk auto parts by shredding and separation, and tested it on incinerator residue. Several test programs on residue and solid waste were demonstrated to Leonard S. Wegman Co. Inc.

6.4.1 Demonstrations on Unincinerated Refuse

The first demonstrations were conducted on unincinerated refuse at the St. Louis prison farm, utilizing a 30 TPH shredder with an 800 hp motor. Handicaps of the demonstration included a drizzling rain, mud conditions, and the lack of any enclosure. In addition, the front-end loader which moves material on to the feed conveyor was not operating and materials had to be thrown on to the conveyor manually. Refinements of problems such as these were not yet complete because of the experimental nature of the demonstrations.

Williams had secured approximately two tons household refuse in plastic bags for the demonstration and various bulk wastes ranging from automobile parts to sofas and mattresses. Each of these items was processed through the machine during the demonstration.

The household refuse presented no problem for the machine and was shredded to a particle size slightly larger than that derived at Madison, Wisconsin. Several refrigerators were crushed without problem although it is possible the motors were not in them and some sofas were shredded to kindling and stuffing. Part of an automobile fender and body were shredded without problem. Many automobile tires without wheel parts were shredded into 6 inch strips and chunks and a couple of mattresses were put through the machine with no apparent difficulty, resulting in stuffing coming off the conveyor. Two men were positioned with long pokers at the vibrating discharge feeder. Since the front-end loader was not working, it was not possible to observe a demonstration of the shredder and its feed system when fully loaded.

The grate openings for the machine were approximately 10 inches x 13 inches. Vertical sizes of most materials were small due to the tremendous size of the shredder and the easily crushed nature of the refuse. In addition, the machine was not fully loaded and therefore a determination of what the size of the crushed materials would be under fully loaded conditions was not possible. On the household refuse, although the grate openings were large, it appeared that the refuse material was primarily 4 inch particles and less.

Williams attributed no volume reduction to the machine. The material was claimed to utilize about 50% of the landfill volume of unshredded refuse.

In this installtion, the discharge vibrating mechanism was below grade and on to a rubber conveyor. It should be possible to separate magnetic materials following the discharge of the machine, but the most logical place seemed to be at the end of the conveyor.

Williams claimed that the hammers on a reversible mill would process approximately 50,000 tons before replacement. The mill at the prison farm was not reversible and therefore should process no more than half that amount.

Even though it was raining at the time of the demonstration, dust was generated in the immediate environment of the machine while shredding some materials. In addition, the noise generated by the machine on certain items was excessive, at an 80 or 90 decible level. The environment for plant operating personnel would have to be suitably protected with regard to both dust and noise.

Williams stated that power consumption ranges from 5 to 10.4 kwh per ton of material.

The company has shredders in operation on solid waste, in Detroit (private), Louisville, San Diego, Altoona, and Tacoma, Washington.

6.4.2 First Separation of Shredded Refuse

Following the first test of the shredder at the prison yard, Leonard S. Wegman Co. Inc. inspected the North Broadway location where the company has its equipment building facilities and has set up a variety of small machines for testing and experimentation purposes in a laboratory adjacent to the main plant. The purpose of this first test was to determine if shredded refuse could be separated into any meaningful categories using a small grinder in the laboratory attached to a device called the VIP Separator.

The VIP Separator feeds by a vibrating feeder onto the shredder passing through an air jet which pushes most of the material onto the hammers for shredding while heavy items such as metal drop through the air jet and out an ejector chute. Material which passes the air jet and goes through the shredder but not through the grates can be ballistically thrown back up into the separator and around onto the vibrating feeder again for further grinding. This particular unit was developed for separation of shredded junk automobiles. The material known as "dirt" (which contains approximately 50% metals) can be shredded, separated and recovered through this one device. The hammermill connected to the VIP Separator is a Williams C-17 Series in which the mill has rings of tips connected to bars which do the grinding. It had a 50 hp motor and an output varying from 1/2 to 1 ton an hour of auto scraps, or up to 5 tons per hour of wood.

For this test the mill was filled with grate bars at 2 inch spacing to determine the effect on shredded refuse as it passed through the separator. The material put into the vibrating feed mechanism was the shredded household refuse which was originally crushed earlier in the day at the prison farm location. As the material proceeded through the machine, three types of separation occurred:

a. A fluff was created from a suction pipe directly under the grate bars which pulled light material through the pipe and into a cyclone where the fluff was separated.

b. The bottom discharge from the grate bars included all the material passing through these 2 inch openings and into a hopper below.

c. The heavies were the materials which dropped through the air jet. The eavies were mostly metal of various types and some organic pieces such as wood or bones.

Williams stated that this concept is being looked at by Detroit Stoker for injection burning. General Electric at the Shelbyville location of the Vortex Incinerator has tested some of their shredded material through this separator in an attempt to remove noncombustibles from their incinerator input feed. GE could not tolerate slagging, therefore the separation of noncombustibles such as glass was essential to their operation.

Although this first test was successful in deriving the three categories mentioned, it did not provide the clean metal material.

6.4.3 Second Separation of Shredded Refuse

The grate bars had been changed to 1/2 inch openings in order to try to derive a cleaner metal product through the air jet. Material separation was occurring but the fluff material did not generate and the 1/2 inch openings were too small for the purpose of separating shredded refuse.

6.4.4 Third Separation of Shredded Refuse

The 1/2 inch grate bar openings were changed for a 1-1/2 x 2 inch grate screen. Using this opening and keeping all other parameters the same, the machine was able to produce a fairly clean metal discharge although it still contained some heavy organics. A fluff was produced which weighed 5 pcy and the material which passed the grate discharge area and dropped into the hopper was 7 pcy. The fluff material appeared to be more like lint in nature, whereas the material which passed into the hopper through the shredder, although shredded originally, had received an additional size reduction (approximately 50%). The difference in the fluff and the grate discharge was very small and no apparent separation of any advantage was occurring at this state.

Overall, the tests for the separation of shredded refuse were able to show that noncombustibles could be removed from shredded material using this VIP Separator. This may be advantageous in providing a more concentrated combustible fraction to an incineration system. In addition, the separated metals might be cleaned and separated into ferrous and nonferrous for subsequent recovery.

6.4.5 First Separation of Incinerator Residue

Using the 1-1/2 x 2 inch grate screen, attempts were made to separate incinerator residue into various classifications.

The incinerator residue was acquired from the St. Louis Municipal Incinerator and appeared to be a fairly standard municipal refuse incinerator residue with the exception that it contained no large massive iron, very little visible organic material and a high quantity of fines. It contained incinerated tin cans and other obviously incinerated material.

On the first test, metal and glass separation did occur through the air jet, but some fines were carried over which were clinging to the metals and glass. No material was derived from the suction directly underneath the grate screen. Most of the material passed the grates to the hopper below. The shredder in this system appeared to have very little effect on particle-size reduction, since most of the material entering the vibrating feed hopper was smaller than 1-1/2 x 2 inches already.

In an attempt to clean up the metals and glass separation through the air jet, the material was fed directly onto the mill rather than through the vibrating feed hopper. This meant that the material would drop on the upswinging hammer and be directly ricocheted through the VIP Separator and back onto the vibrating feed hopper. The effect of this was to break up some of the metals and glass into smaller materials, thereby allowing them to pass through the grate screen and into the hopper below rather than dropping out through the air jet area. However, what did drop through the air jet was much cleaner. Therefore, the company felt that if a smaller grate screen were to be used, less material would pass through the mill and more would come out at the air jet. It should be noted here that it seemed possible that another answer could have been to increase the air velocity at the air jet and carry more fines past the air jet exit.

6.4.6 Second Separation of Incinerator Residue

A 1/2 in. x 1 in. grate screen was fitted into the hammer mill. All feeding of incinerator residue was done directly onto the mill, without the vibrating feeder. This run produced a good size separation. Large items dropped through the air jet into the discharge chute. All other material passed the 1/2 inch openings to the hopper below. Very little if any crushing occurred since most material was of small particle size. This was also due to the fact that the material entered the mill on the up side of the hammers and was shot onto the separator and into the feed hopper and then into the air jet exit. This meant that it did not pass between the hammers and the grate screen. The results of this run were promising.

6.4.7 The Roller Mill Test

In order to determine the possibility of separating the small nonferrous metal, glass, and organic material which may pass into the mill discharge, a nearby roller mill of a small size was set up. This particular device was a roller mill attached to a specific gravity separator which could divert, through suction, lighter materials into two or three classifications. This particular unit also contained a heater which dried the wet material as it passed through the roller mill. Although little material was available for this particular test, the results were significant in terms of separating the very light material from the glass and other heavier items which pass through the mill.

The entire system, the separator, the shredder, and the roller mill, holds promise for potential for use in the incinerator residue recovery concept.

CHAPTER 7

REGIONAL IMPACT OF RESIDUE RECOVERY

Sixty-one municipal incinerators handle solid waste within 50 miles of New York City. These metropolitan area incinerators have a combined capacity of 16,209 TPD. The individual locations, plant sizes and dates of construction appear on Figure 11-1 and Table 11-1. Operating on the average at the same residue generating characteristics as the Hempstead Harbor facility, these plants would be capable of generating a total of approximately 2,400 TPD of residue, or 886,000 tons per year. Daily and yearly potential residue recovery, by component, are tabulated below:

METROPOLITAN AREA RESIDUE RECOVERY POTENTIAL

	Tons per day	Tons per year
Ferrous	728	266,000
Nonferrous		
Aluminum	15	5,300
Heavies	15	5,300
Glass		
Clear	516	188,000
Colored	396	144,000
Sand	248	161,000

Purchase commitments for recovered residue components have been difficult to obtain. Clear glass cullet has been accepted by glass manufacturers primarily as an experimental material, with small quantities allocated to each manufacturer. It was not possible to get commitments from steel manufacturers for purchase of steel tonnages generated on a wider scale than North Hempstead's or statements of interest in these tonnages. Apparently, one favorable aspect of the willingness, however reluctant, of certain companies to accept future material may well be the small volume of the materials. It is possible that there is a desire within industry to stand behind its public expressions of interest in the environment, but only at a limited cost.

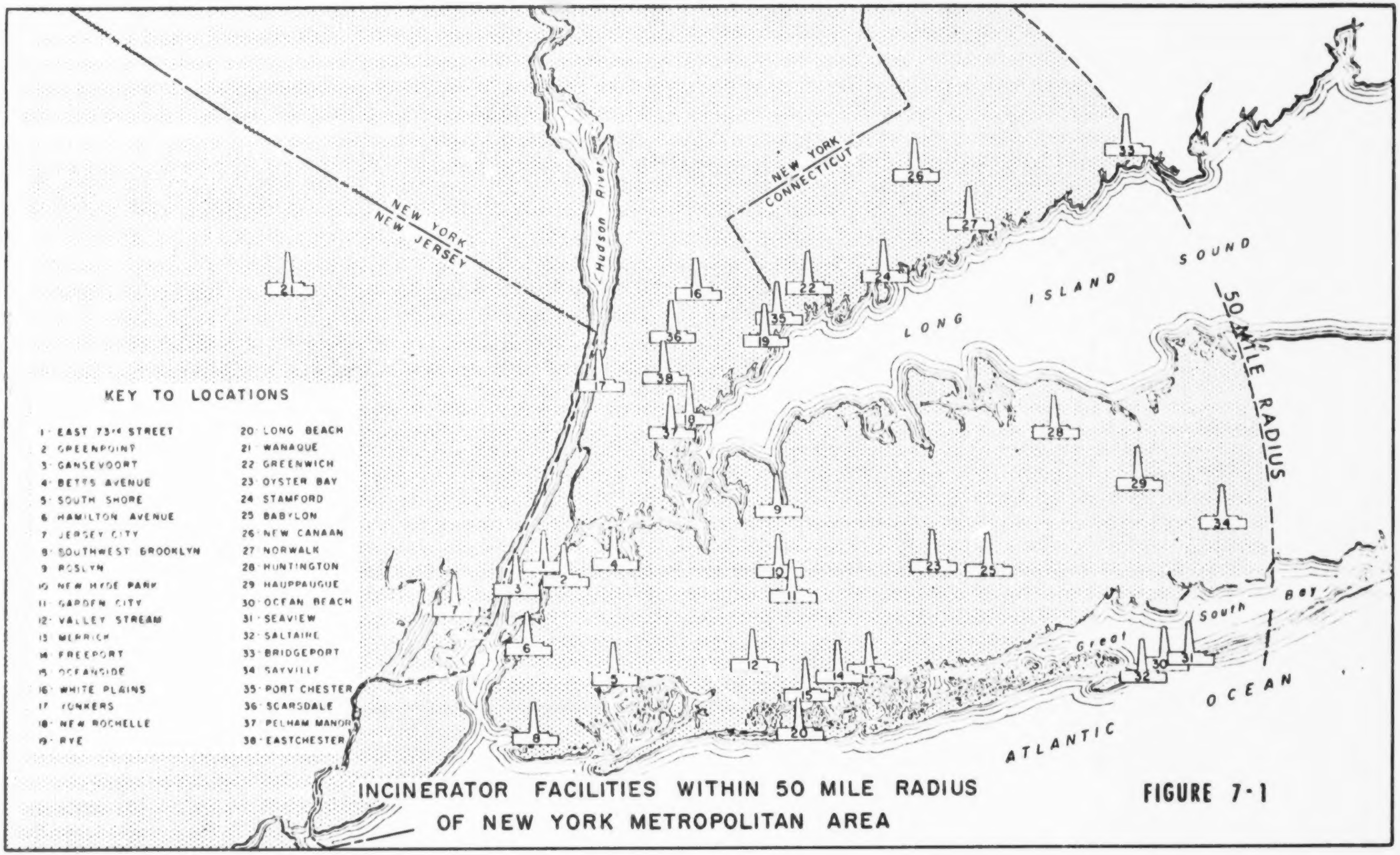
This reluctant stance on the part of a certain segment of industry which is hesitantly willing to accept material and of others in the same fields who have no interest at all reflects a basic unwillingness to utilize the technology generated by the Bureau of Mines' work and studies such as this.

If municipal incinerator residue could be recovered and marketed on a regional scale, as projected at North Hempstead, landfill savings would amount to 580 acre-ft annually. At a landfill height of 20 ft, this metropolitan area recycling would permit the annual preservation of over 29 acres of land. The ecological implications of such savings are discussed in Chapter 10. As an example of the impact of residue recovery on the mining of virgin ores, the 269,000 tons of ferrous per year which could be saved from municipal incinerator residue within 50 miles of New York City would result in a savings of 800,000 tons of taconite ore.

TABLE 7-1

MUNICIPAL INCINERATOR FACILITIES WITHIN 50-MILE RADIUS OF NEW YORK METROPOLITAN AREA

Location	Year Constructed	Nominal Capacity (TPD)
East 73rd Street (New York City)	1957	1,000
Greenpoint (Brooklyn)	1959	1,000
Gansevoort (New York City)	1957	660
Betts Avenue (Queens)	1950	1,000
South Shore (Brooklyn)	1954	1,000
Hamilton Avenue (Brooklyn)	1962	1,000
Southwest Brooklyn	1961	1,000
Roslyn (Long Island)	1967	600
New Hyde Park (Long Island)	1956	250
Garden City (Long Island)	1963	175
Valley Stream (Long Island)	1962	200
Merrick (Long Island)	1952	600
Freepoint (Long Island)	1964	150
Oceanside (Long Island)	1965	750
Long Beach (Long Island)	1952	200
Oyster Bay No. 1 (Long Island)	1956	500
Oyster Bay No. 2 (Long Island)	1967	400
Babylon (Long Island)	1930	90
Hungtington (Long Island)	1966	660
Hauppaugue (Long Island)	1961	244
Sayville (Long Island)	1968	300
White Plains (Westchester)	1958	400
Yonkers (Westchester)	1951	450
New Rochelle (Westchester)	1939	400
Rye (Westchester)	1959	150
Port Chester (Westchester)	1951	120
Scarsdale (Westchester)	1960	150
Pelham Manor (Westchester)	1931	85
Eastchester (Westchester)	1960	200
Harrison (Westchester)	1954	150
Larchmont (Westchester)	1941	120
Mount Kisco (Westchester)	1948	40
Greenwich (Connecticut)	1961	250
Stamford (Connecticut)	1958	150
New Canaan (Connecticut)	1955	50
Norwalk (Connecticut)	1963	360
Bridgeport No. 1 (Connecticut)	1960	200
Bridgeport No. 2 (Connecticut)	1955	300
Darien (Connecticut)	1941	130
Jersey City (New Jersey)	1957	600
Wanaque (New Jersey)	1970	125
Total		16,209 TPD


NEW YORK
NEW JERSEY
Hudson River
NEW YORK
CONNECTICUT
LONG ISLAND SOUND
50 MILE RADIUS
Great South Bay
ATLANTIC OCEAN
KEY TO LOCATIONS
1· EAST 73rd STREET
2 GREENPOINT
3· GANSEVOORT
4· BETTS AVENUE
5· SOUTH SHORE
6 HAMILTON AVENUE
7 JERSEY CITY
8· SOUTHWEST BROOKLYN
9 ROSLYN
10 NEW HYDE PARK
11 GARDEN CITY
12· VALLEY STREAM
13 MERRICK
14 FREEPORT
15 OCEANSIDE
16· WHITE PLAINS
17 YONKERS
18· NEW ROCHELLE
19· RYE
20· LONG BEACH
21 WANAQUE
22 GREENWICH
23 OYSTER BAY
24 STAMFORD
25 BABYLON
26· NEW CANAAN
27 NORWALK
28· HUNTINGTON
29 HAUPPAUGUE
30· OCEAN BEACH
31 · SEAVIEW
32· SALTAIRE
33· BRIDGEPORT
34 SAYVILLE
35· PORT CHESTER
36· SCARSDALE
37 PELHAM MANOR
38 · EASTCHESTER
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INCINERATOR FACILITIES WITHIN 50 MILE RADIUS OF NEW YORK METROPOLITAN AREA

FIGURE 7-1

CHAPTER 8

RESIDUE RECOVERY FACILITY FOR NORTH HEMPSTEAD

8.1 Design Criteria

8.1.1 Location

For ease in material handling and for the estimated costs to be reliable the facility should be located within a 2,000 foot radius from the present residue conveyor discharge area. The proposed location is indicated in Figure 8-1.

8.1.2 Process

The plant is designed to process the present output of the Roslyn Harbor incinerator and the operation will be coordinated to form an integrated facility for the continuous processing of raw refuse to salable materials. The plant is to be designed for maximum reliability and semi-automated performance to require a small number of attending personnel.

The residue is received wet from the incinerator residue conveyor and the separation process is continued wet. Drying is effected only for the finished glass product. The water used in washing is recovered and recycled.

The plant is designed for selective expansion. The initial phase encompasses primary and secondary sizing for ferrous metal separation. The second phase introduces tertiary grinding and heavy media separation for non-ferrous metals. The third phase includes high intensity magnetic separators for clear glass recovery and a Wilfley vibrating table for separating zinc, copper and lead.

8.1.3 Capacity

Roslyn Harbor Incinerator - Town of North Hempstead:

The practical residue generation capacity of the Roslyn plant is calculated as follows:

600 TPD (nominal) x 7 days = 4,200 TPW

4,200 TPW x .85 x 6/7 (practical operation factors) = 3,090 TPW

On a monthly basis:

3,090 T/W x 4-1/3 W/M = 13,390 TPM

At 80% burnout the dry residue generated is:

13,390 TPM x .20 = 2,680 TPM dry residue; or

89.3 TPD dry residue generated continuously.

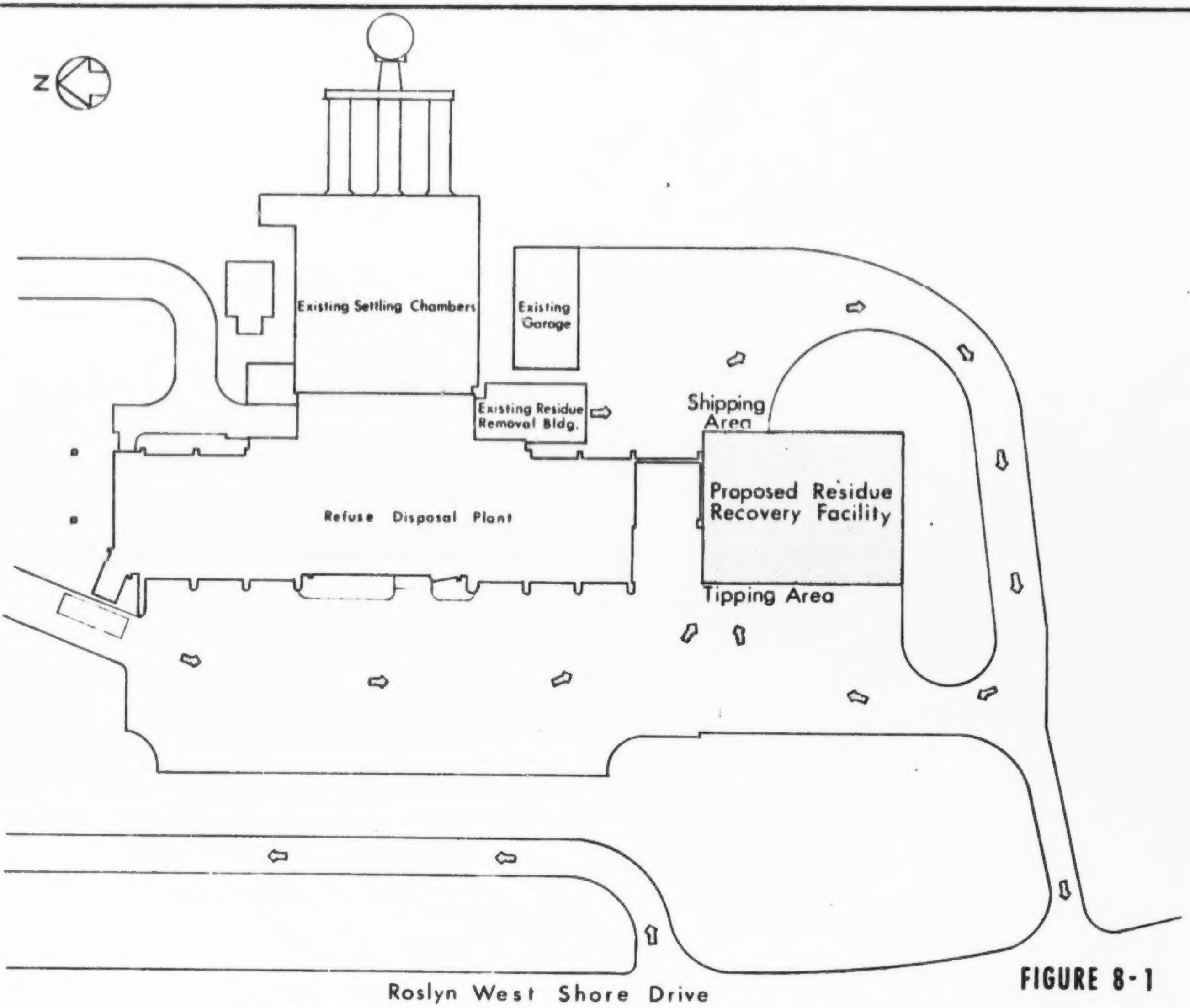

Z
Existing Settling Chambers
Existing Garage
Existing Residue Removal Bldg.
Shipping Area
Proposed Residue Recovery Facility
Refuse Disposal Plant
Tipping Area
Roslyn West Shore Drive

FIGURE 8-1

PLOT PLAN — PROPOSED RESIDUE RECOVERY FACILITY

Additional Capacity for Residue Generation from Nearby Incinerators

New Hyde Park Incinerator (Denton Avenue) - Town of North Hempstead:

The practical residue generating capacity of the Denton Avenue facility amounts to 225 x .85 x 6/7 x .2 = 33 TPD.

During the last five months of 1971, the monthly average tons of refuse incinerated in the New Hyde Park plant was 3,130 tons. With an 80% burnout rate the average dry residue produced was 616 TPM, or only 20.5 TPD.

Oyster Bay Incinerators (Winding Rd, Old Bethpage) - Town of Oyster Bay:

The monthly average tons of refuse incinerated in the Oyster Bay plants, No. 1 and No. 2, in the last three months of 1971 is 14,640 tons. With an 80% burnout rate, the dry residue produced is 2,930 TPM or 97.7 TPD.

Garden City Incinerator (Cherry Valley Rd) - Town of Hempstead:

The monthly average tons of refuse incinerated in this plant for the last five months of 1971 is 1,750 tons. With an 80% burnout rate, the dry residue produced is 350 TPM or 11.7 TPD.

Total

The total residue generated by the nearby incinerators listed above has averaged 130 TPD during the latter part of 1971.

The feasibility of erecting a central residue recovery plant to service the above four incineration complexes merits investigation. The geographic center of the area would be in Westbury, and the approximate distance to the outermost plant is six miles. The central residue recovery facility would process the present combined daily average output of over 200 tons of dry residue.

The initial facility to handle the residue of this local region could be sized for 300 TPD based on a six day processing week. Provision for future expansion of the facility would be included in the original design.

The residue recovery plant to handle Roslyn's residue will vary in size depending on mode of operation. The plant may be operated five, six, or seven days a week and on one, two, or three shifts per day. It is desirable to set aside one day of the week for maintenance if a multi-shift mode of operation is selected. Receiving the residue, however, will be on a continuous basis.

Under the latter conditions, for a three-shifts day, the hourly rate will be:

a) 89.3 TPD x 1/24 x 7/5 - 5.20 TPH for a 5-day week.

b) 89.3 TPD x 1/24 x 7/6 - 4.34 TPH for a 6-day week.

TABLE 8-1

CAPACITY OPTIONS FOR RESIDUE RECOVERY FACILITY OF 90 TPD PRACTICAL CAPACITY

	Nominal Capacity			
	2 Shift Operation		3 Shift Operation	
	TPH	TPD	TPH	TPD
5 Days	7.8	125	5.2	125
6 Days	6.51	104	4.3	104

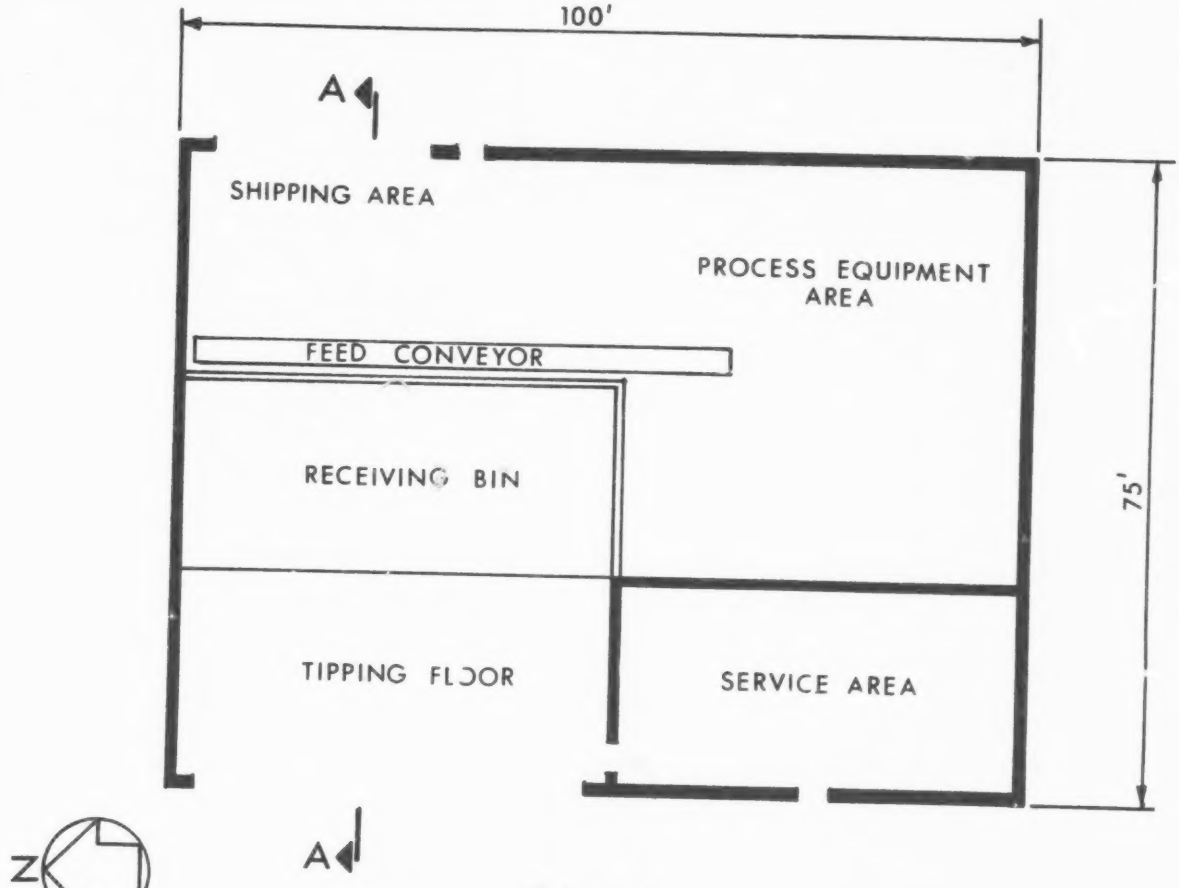
TABLE 8-2

PLANT CAPACITY ANALYSIS

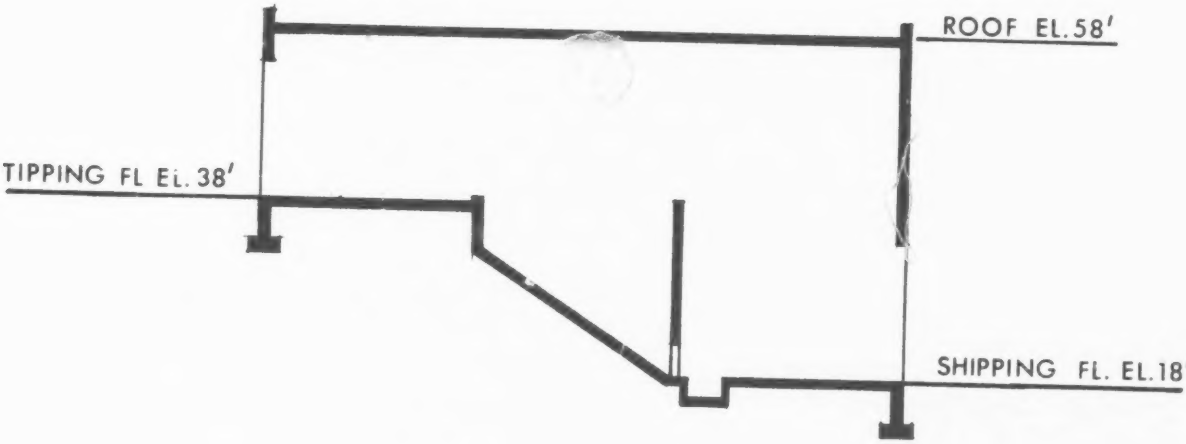
VARIATION OF RESIDUE RECOVERY PLANT CAPACITY WITH PLANT SIZE

Plant Reference	Number of Shifts	Nominal Capacity (Dry)		Nominal Capacity (Wet - 38%)	
		TPH	TPD	TPH	TPD
1	1	4.16	33	6.72	54
	2	4.16	67	6.72	108
	3	4.16	100	6.72	161
2*	1	6.25	50	10.0	80
	2	6.25	150	10.0	160
	3	6.25	150	10.0	240
3	1	12.5	100	20.0	160
	2	12.5	200	20.0	320
	3	12.5	300	20.0	480
4	1	20.0	160	32.3	258
	2	20.0	320	32.3	516
	3	20.0	480	32.3	774
5	1	31.2	250	50.0	400
	2	31.2	500	50.0	800
	3	31.2	750	50.0	1200
6	1	41.6	333	67.2	538
	2	41.6	667	67.2	1080
	3	41.6	1000	67.2	1610

*Plant Reference 2 is taken as design basis. This selection allows expansion to 150 TPD when operating 3 shifts/day.


100'
A
SHIPPING AREA
PROCESS EQUIPMENT AREA
FEED CONVEYOR
RECEIVING BIN
TIPPING FLOOR
SERVICE AREA
75'
A
N

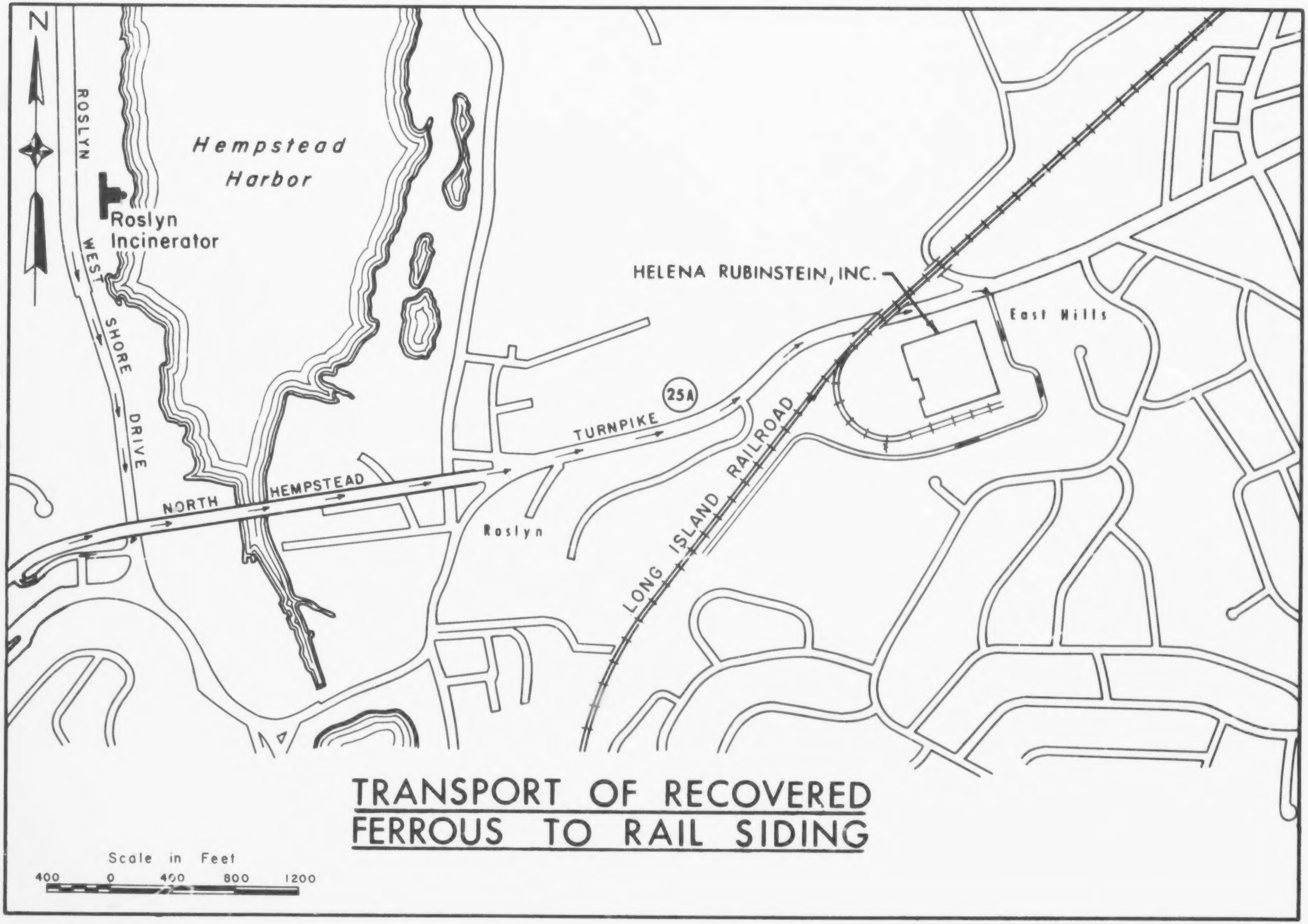
PLAN


ROOF EL.58'
TIPPING FL EL. 38'
SHIPPING FL. EL.18'

SECTION A–A

PROPOSED INCINERATOR RESIDUE RECOVERY FACILITY

FIGURE 8-2


N
ROSLYN
WEST
SHORE
DRIVE
Hempstead
Harbor
Roslyn
Incinerator
NORTH
HEMPSTEAD
TURNPIKE
25A
Roslyn
LONG ISLAND RAILROAD
HELENA RUBINSTEIN, INC.
East Hills
Scale in Feet
400
0
400
800
1200

TRANSPORT OF RECOVERED FERROUS TO RAIL SIDING

FIGURE 8-3

Similarly, operating two-shifts day, the hourly rate will be:

a) 89.3 TPD x 1/16 x 7/5 = 7.80 TPH for a 5-day week.

b) 89.3 TPD x 1/16 x 7/6 = 6.51 TPH for a 6-day week.

The plant capacities attainable with the above hourly rates are illustrated in Table 8-1. Also, nominal plant sizes are shown in Table 8-2.

The design plant size selected for Roslyn is plant ref. 2, Table 8-2 for 100 TPD, at 6.25 TPH, operating two shifts per day, 6 days per week. This plant matches the requirements for handling the residue output of the Roslyn incineration plant.

Provision for handling 150 TPD of dry residue is built into the plant, by allowing a third shift to be added in the future.

8.1.4 Output Materials

The rate of output of recovered fractions that would be expected as a result of processing 100 TPD of residue through the residue recovery facility appear on Table 8-3. The single values in the table are for simplified reference, although there was a variation between the two samples tested by the Bureau of Mines. Approximately 32 TPD of ferrous metals, 22 TPD clear glass, 17 TPD colored glass and 20 TPD sand would be expected. Aluminum would be produced at a rate of approximately 25 tons per month and heavy non-ferrous at a rate of 17 tons per month. By operating on three shifts so that an input of 150 TPD could be handled, the values shown would be increased by 50% (Table 8-4).

The continuous variation of output of each residue component for a continuous variation of volumes processed is shown on Figure 8-4, "Residue Composition". For values under discussion in this report, refer to the portion labeled "Proposed Plant Operating Range" on the graphs. This figure also illustrates the range in composition of the output that may be expected from material of the analysis of North Hempstead residue, as tested twice by the Bureau of Mines. For instance, referring to the figure, the input of 100 TPD of residue would result in ferrous metal output of between 30 and 40 tons per day. Further information presented in Figure 8-4 is the range in residue composition which the Bureau of Mines had experienced from testing of the residue from many other incinerators.

8.2 Transport of Residue to Recovery Facility

Residue will be received in open top trucks at the incineration plant residue conveyors and transported to the receiving bin of the recovery facility after weighing-in at the existing scalehouse. A paved road and return loop will be built connecting the two plants. Figure 8-3 indicates the proposed location of the facility and accesses.

A possible future alternate method of residue delivery is by means of a residue transfer conveyor connecting the incineration plant's residue discharge and the facility's storage bin.

RESIDUE COMPOSITION

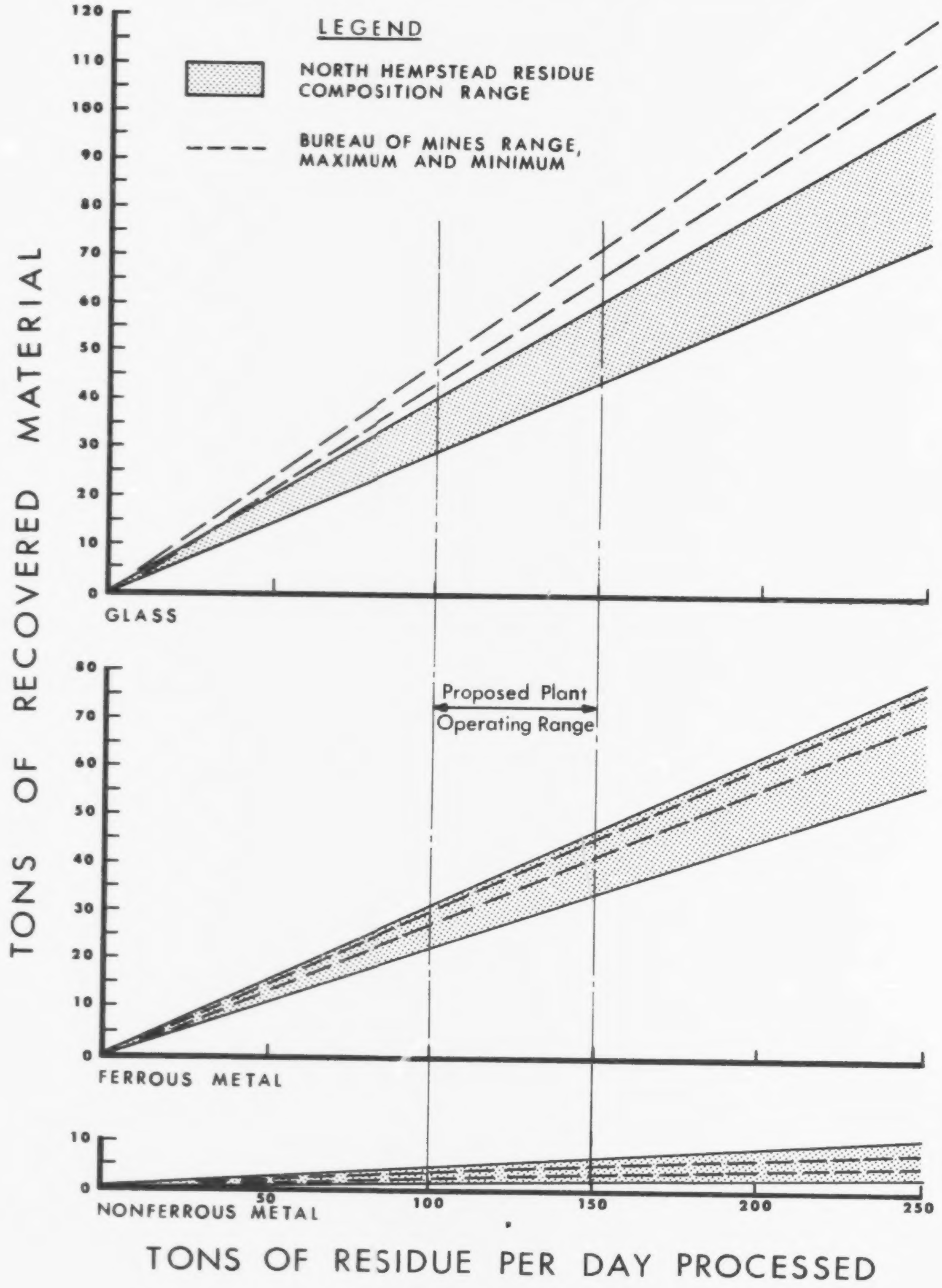


FIGURE 8-4

TABLE 8-3

OUTPUT MATERIALS

RESIDUE RECOVERY FACILITY

100 TPD RESIDUE INPUT

	ACTUAL OUTPUT			
	TPH	TPD*	Tons/Week**	Tons/Month
Ferrous	2.03	32.4	194	833
Non-ferrous (Aluminum)	0.06	.96	5.8	24.7
Non-ferrous (Heavies)	0.04	.64	3.8	16.5
Clear Glass	1.38	22.0	132	566
Colored Glass	1.10	17.6	105.6	452
Sands	1.27	20.3	122	522
Dewatered Pulp	0.37	5.91	35.5	152
TOTAL	6.25	100	600	2,566

* 2 shift - 16 hr operation at input rate of 6.25 TPH
**6 day week operation

TABLE 8-4

ANNUAL OUTPUT RANGE
RESIDUE RECOVERY FACILITY
150 TPD CAPACITY

	ACTUAL OUTPUT (TONS/YEAR)	
	100 TPD Residue Input	150 TPD Residue Input
(1) Ferrous	9,996	14,994
(2) Non-ferrous		
Aluminum	296	444
Heavies	198	297
(3) Glass		
Clear	6,792	10,188
Colored	5,424	8,136
(4) Sand	6,264	9,396
(5) Dewatered Pulp	1,824	2,736
TOTAL	30,794	46,191

8.3 Facility Description

The facility consists principally of a storage bin with tipping floor, a process equipment area, a shipping area and an administration area including space for the electrical control gear. Figure 8-2 illustrates the general layout of the proposed facility.

8.3.1 Receiving and Feed Conveyor

The storage bin of 600 cubic yards capacity or approximately three days holding time, has a sloping base and hydraulically controlled gates at the bottom. The gates open to a feed conveyor recessed in the floor and travelling upgrade to the primary shredder. The feed system is merely a schematic. An alternate desirable for backup and to free jams would be a mobile crane operating between the pit and the apron conveyor.

The tipping floor is 50 ft long for better dispersion of the residue and to reduce the depth which affects the building profile. The elevation of the tipping floor, 38'-0", is the same as that of the incineration plant residue discharge floor.

The four foot wide apron feed conveyor carries the wet unsorted residue at a normal speed of 5 feet per minute. A recording conveyor scale weighs the feed and controls the opening of the hydraulic doors at the bottom of the bin, for a constant, uniform feed to the separation facility.

The feed conveyor is inclined to deliver at the maximum height permissible by the building layout for gravity flow. A building height of forty feet is envisaged, allowing a practical drop of approximately thirty feet for the flow of material.

8.3.2 Primary and Secondary Separation

The flow diagram in Figure 8-5 illustrates the proposed residue recovery facility. The residue is delivered to a triple deck vibrating screen where it is washed and sized as fed to the primary shredder. The latter receives all residue larger than 4 inches in diameter and fragmentizes it to a maximum size of 2 inches. The shredder of hammermill design is selected with emphasis on the dimensions of the receiving opening.

The second deck of the vibrating screen is equipped with an 1/8 inch opening screen. The surface material, minus 4 inches and plus 1/8 inch is discharged to the belt conveyor which also receives the output of the primary shredder.

A suspended electromagnet, belt type, picks up the ferrous material of the take-away conveyor and drops it to a transfer belt conveyor that feeds a briquetter.

The third deck screen sizes the minus 20 mesh material which is washed down a hopper and pumped to the water recovery and sands separation section of the plant. The plus 20 material is delivered with screw conveyors to a vibrating feeder which collects also plus 20 material from the secondary and tertiary shredding and screening branches. An electromagnetic drum separator removes the plus 20 ferrous material that is belt-conveyed to the briquetter.

After removal of the ferrous in the primary sizing and crushing process the residue is similarly fed to a secondary triple deck vibrating screen that delivers washed plus 3/4" material to the secondary shredder. This machine is also of the hammermill type and will grind the input to a minus 1/2" size. The output and the residue collected on the second deck of the screen, minus 3/4" and plus 4 mesh, is collected on the same take-away belt conveyor that transfers to a tertiary triple deck screen with screens of 1/2" mesh, 4 mesh and 20 mesh respectively.

An electromagnetic drum separator located at the feed end of the tertiary screen removes the minus 1/2", plus 4 mesh ferrous metal which is fed to the briquetter. The latter produces briquettes sized 6" x 6" x 6" at the rate of 1.5 tons an hour.

8.3.3 Tertiary Separation

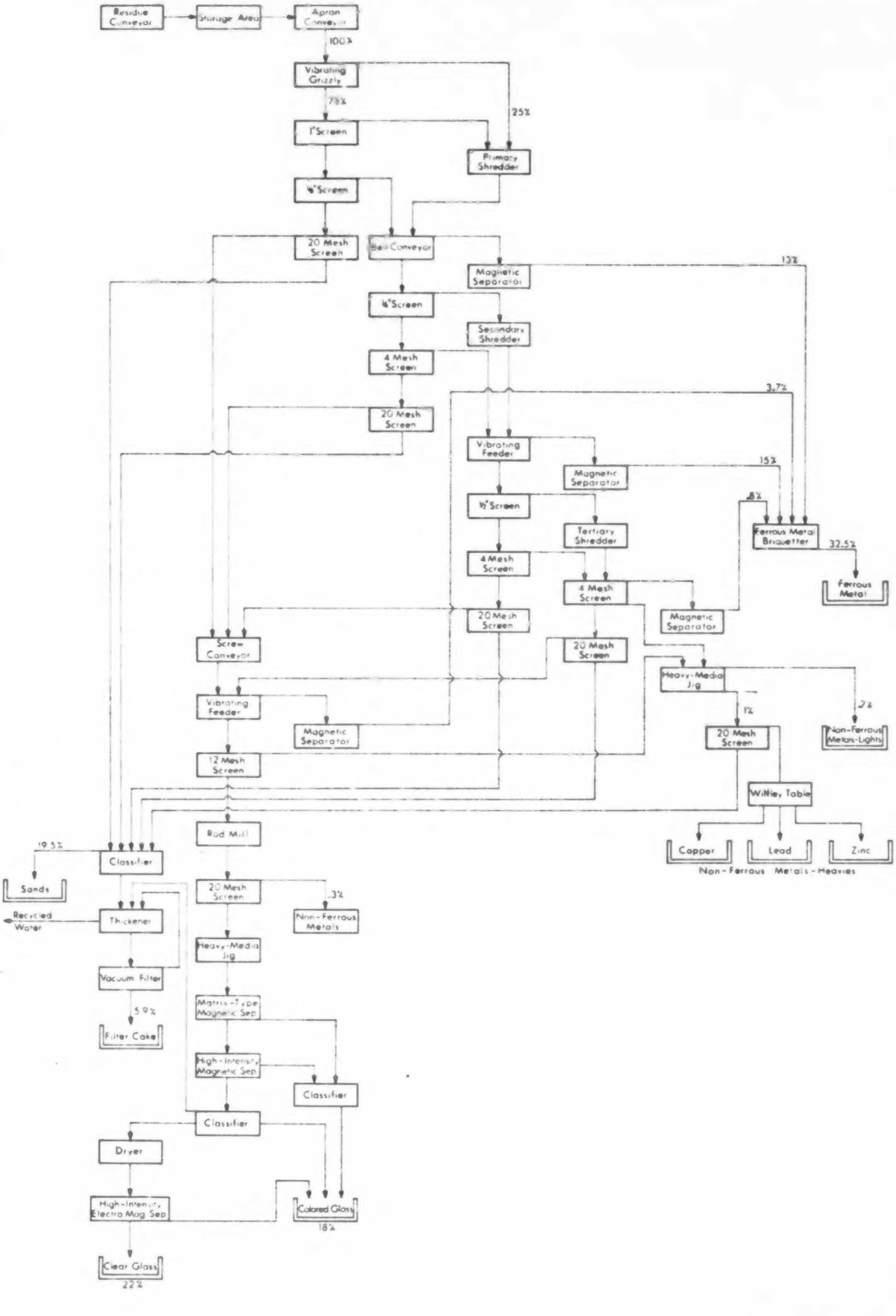
The tertiary shredder that is to reduce the minus 1/2" residue to plus 4 mesh may be a rodmill sized for this duty. Its output and that of the second deck of the tertiary screen fall on a vibrating screen which separates the minus four residue. The plus four is freed of its ferrous contents with an electromagnetic drum separator that feeds to the briquetter. Non-ferrous, plus 4 mesh material is thus obtained and further separation, if proven economical, can be effected into light and heavy metals with a heavy-media separator containing a ferro-silicon-water slurry having a specific gravity of 2.95. The float product, 96 percent aluminum, is collected and stored for bulk delivery. The sink product or heavies, contains approximately 50% copper and 40% zinc. If economically justifiable, separation of the heavies will be made with a diagonal-deck concentrating table.

8.3.4 Glass Recovery

The second deck of the tertiary shredder discharge screen is a 12 mesh size. The plus 12 mesh residue drops to a vibrating feeder which also collects the plus 20 mesh material of the tertiary triple deck screen. An electromagnetic drum separator frees the ferrous material off this material and it is fed to the briquetter.

The non-ferrous fine mesh is screened with a 12 mesh screen and the plus 12 is processed with the non-ferrous plus 4 material obtained from the tertiary grinder.

The minus 12 non-ferrous is fed to a rodmill. A 20 mesh vibrating screen follows the rodmill; the plus 20 non-ferrous may be further upgraded or sold in this form. The minus 20 mesh slurry is fed to two high-intensity matrix-type magnetic separators in series that deliver two products: colored and clear glass. The colored glass is stored in draining containers that permit dewatering through percolation. The clear or colorless glass cullet is dewatered in a hollow flight, screw type dryer. Further upgrading of the latter is attained with a high intensity electromagnetic separator.


Residue Conveyor
Storage Area
Apron Conveyor
100%
Vibrating Grizzly
75%
25%
1" Screen
Primary Shredder
¼" Screen
20 Mesh Screen
Belt Conveyor
Magnetic Separator
13%
¼" Screen
Secondary Shredder
4 Mesh Screen
20 Mesh Screen
3.7%
Vibrating Feeder
Magnetic Separator
15%
½" Screen
.8%
Tertiary Shredder
Ferrous Metal Briquetter
32.5%
4 Mesh Screen
4 Mesh Screen
Ferrous Metal
20 Mesh Screen
Magnetic Separator
Screw Conveyor
20 Mesh Screen
Heavy-Media Jig
Vibrating Feeder
1%
.2%
Magnetic Separator
20 Mesh Screen
Non-Ferrous Metals-Lights
12 Mesh Screen
Willey Table
Rod Mill
19.5%
Classifier
Copper
Lead
Zinc
Non-Ferrous Metals-Heavies
Sands
20 Mesh Screen
.3%
Recycled Water
Thickener
Non-Ferrous Metals
Heavy-Media Jig
Vacuum Filter
5.9%
Matrix-Type Magnetic Sep
Filter Cake
High-Intensity Magnetic Sep
Classifier
Classifier
Dryer
High-Intensity Electro Mag Sep
Colored Glass
18%
Clear Glass
22%

FLOW SHEET - PROPOSED INCINERATOR RESIDUE RECOVERY FACILITY

FIGURE 8-5

FLOW DIAGRAM – PROPOSED INCINERATOR RESIDUE RECOVERY FACILITY

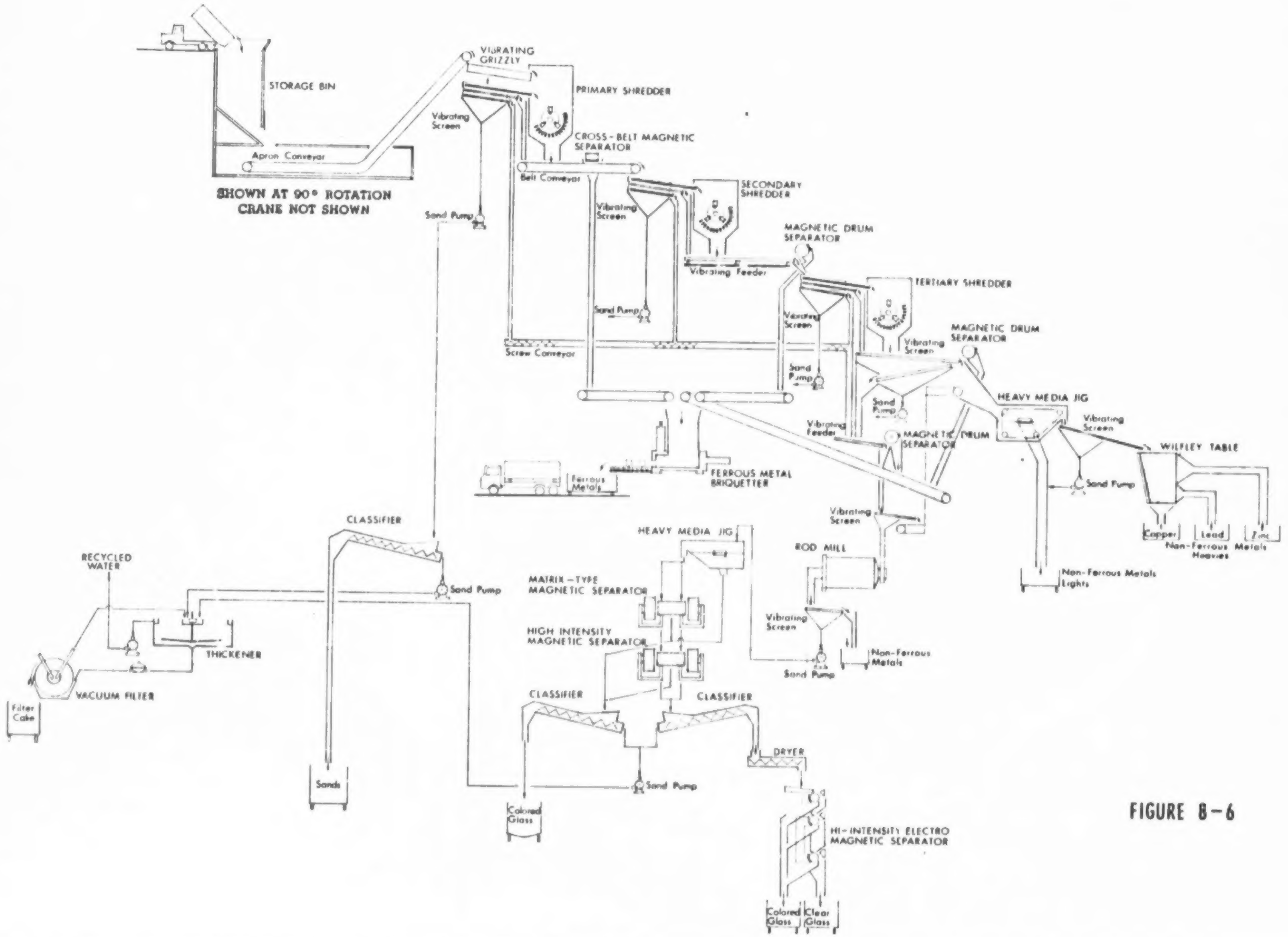

STORAGE BIN
Apron Conveyor
SHOWN AT 90° ROTATION
CRANE NOT SHOWN
VIBRATING GRIZZLY
PRIMARY SHREDDER
Vibrating Screen
CROSS-BELT MAGNETIC SEPARATOR
Belt Conveyor
Sand Pump
SECONDARY SHREDDER
Vibrating Screen
MAGNETIC DRUM SEPARATOR
Vibrating Feeder
Sand Pump
TERTIARY SHREDDER
Vibrating Screen
Screw Conveyor
Sand Pump
Vibrating Screen
MAGNETIC DRUM SEPARATOR
Sand Pump
HEAVY MEDIA JIG
Vibrating Screen
WILFLEY TABLE
Vibrating Feeder
MAGNETIC DRUM SEPARATOR
Ferrous Metals
FERROUS METAL BRIQUETTER
Sand Pump
Copper
Lead
Zinc
Non-Ferrous Metals Heavies
Non-Ferrous Metals Lights
Vibrating Screen
ROD MILL
Vibrating Screen
Sand Pump
Non-Ferrous Metals
CLASSIFIER
RECYCLED WATER
Sand Pump
HEAVY MEDIA JIG
MATRIX-TYPE MAGNETIC SEPARATOR
HIGH INTENSITY MAGNETIC SEPARATOR
THICKENER
VACUUM FILTER
Filter Cake
CLASSIFIER
CLASSIFIER
DRYER
Sands
Sand Pump
Colored Glass
HI-INTENSITY ELECTRO MAGNETIC SEPARATOR
Colored Glass
Clear Glass

FIGURE 8-6

TABLE 8-5

EQUIPMENT LIST

150 TPD RESIDUE RECOVERY FACILITY

ITEM	DESCRIPTION	QUANTITY	SIZE	ITEM	DESCRIPTION	QUANTITY	SIZE
1	Storage Bin with Feed Gates	1	400 T Holding Capacity (Wet) (22' W x 50' Lg x 15' Deep Avg.)	25	Belt Conveyor	1	.94 TPH (2' - 0" W)
2	Charging Apron Conveyor	1	.10 TPH (Wet) (4' W x 80' LG)	26 & 27	3-Stage High Intensity Magnetic Separator	1	2.5 TPH Solids in Loose Slurry
3	Vibrating Screen	1	10.4 TPH (4' 6" W)	28	Spiral Classifier	1	1.25 TPH Solids (Clear Glass)
4	Primary Shredder	1	2.5 TPH (Feed Ops: 53"W x 52"H)	29	Spiral Classifier	1	1.25 TPH Solids (Clear Glass)
5	Take-Away Belt Conveyor	1	9.6 TPH (3'W x 20' LG)	30	Spiral Classifier	1	1.25 TPH Solids (Sand Extract)
6	Suspended Magnetic Separator	1	1.0 TPH	31	Thickener	1	.37 TPH Solids 8' Dia.
7	Vibrating Screen	1	8.4 TPH (3'-6"W)	32	Drum Filter	1	.37 TPH Solids
8	Secondary Shredder	1	4.5 TPH	33	Thickener Underflow Pump	1	200 GPM Underflow
9	Vibrating Feeder	1	4.5 TPH (3'-0"W x 18'-0" LG)	34	Dryer, Clear Glass	1	3.5 TPH @40% Solids (10" Dia. x 20' LG)
10	Drum Separator	1	1 TPH (3'-0" W)	35	Dryer, Colored Glass	1	3 [illegible]H @40% Solids (10" Dia. x 20' LG)
11	Vibrating Screen	1	5.25 TPH	36	Screw Conveyor	1	1.3 TPH (8" Dia. x 15' LG)
12	Rod Mill Tertiary Grinder	1	1.30 TPH	37	Screw Conveyor	1	1.6 TPH (8" Dia. x 15' LG)
13	Vibrating Screen	1	4 TPH (3'-0" W)	38	Screw Conveyor	1	3.7 TPH (12" Dia. x 25' LG)
14	Drum Separator	1	.1 TPH (2'-0" W)	39	Wilfley Table	1	1.1 TPH Wet
15	Heavy Media Jig	1	.3 TPH	40	Belt Scale	1	Infeed Conveyor 6.25 TPH (Nom.)
16	Vibrating Feeder	1	4.6 TPH	41	Mixing Tank	1	Sized to Match Filter
17	Drum Separator	1	.5 TPH (2'-0" W)	42	Thickener Overflow Pump	1	400 GPM, 10 HP
18	Vibrating Screen	1	4 TPH (2'-0" W)	43	Sand Pump	8	For Screens & Classifiers 50 GPM
19	Rod Mill	1	2.52 TPH Solids in Loose Slurry	44	Hopper	3	For Primary & Secondary Shredders & Briquetter
20	Briquetting Machine	1	2 TPH (6" x 6" x 6" Bale)	45	Chutes	24	All Components
21	Vibrating Screen	1	4 TPH (2'-0" W)	46	Heavy Media Jig for Non-Ferrous Fines	1	2.5 TPH Dry
22	Belt Conveyor	1	.26 TPH (1'-6" W)	47	Hi-Intensity Electromagnetic Separator	1	1.38 TPH Dry
23	Belt Conveyor	1	.81 TPH (1'-6" W)				
24	Belt Conveyor	1	.94 TPH (2'-0" W)				

TABLE 8-6

EQUIPMENT LIST - PRODUCT CONTAINERS

150 TPD RESIDUE RECOVERY FACILITY

Item	Description	Quantity	Container Capacity (TPD)	Container Size
C-1	Ferrous metal briquette containers	3	32.5	20 CY Roll-on, Roll-off (7'W x 18.5"L x 5.5'H)
	Carrier truck for ferrous metal briquette containers	1		25T Payload
C-2	Non-ferrous metals (Aluminum)	2	1.5	3 CY (4' x 4' x 5')
C-3	Non-ferrous metals ("Heavies")	2	1.5	3 CY (4' x 4' x 5')
C-4	Colored Glass	4	18	9 CY (10'L x 5'W x 5'H)
C-5	Clear Glass	5	22	9 CY
C-6	Non-ferrous metals (Aluminum 20 Mesh)	2	.32	55 Gallon Drum
C-7	Sands	3	2	3 CY
C-8	Filter Cake	2	6	9 CY
C-9	Inspection Station	2	2	3 CY

8.3.5 Water Recycling

Wash-up water drained off the screens, hoppers and conveyor pans is pumped to a spiral classifier for dewatering. The sands thus collected are used for fill.

The overflows from this classifier and the two glass product screw classifiers are pumped to a thickener. A flocculant is added to the classifier overflows as pumped to the thickener to improve the settling rate.

The overflow from the thickener is reused as process water. The underflow is fed to a drum filter that further dewaters the sludge to produce filter cake that is trucked to a landfill site. The filtrate is returned to the thickener.

8.3.6 Equipment Summary

Equipment required for the facility is listed in Table 8-5, sizes to handle 150 TPD plant capacity. The rates through each piece of equipment are included. End product containers to facilitate storage and containerized shipment, where applicable, are listed by quantity and rate of content generation.

8.4 Product Quality

It is recognized initially that the residue recovery facility's function is to convert residue to saleable materials at the lowest product cost. Because of space, specialized operation and other considerations, the upgrading and refining of products to a degree higher than the accepted standard by the purchaser is excluded.

No problem is anticipated in ferrous separation other than oxides and a low degree of contamination by entrainment in magnetic pick-up. Responses from prospective users indicate the recovered ferrous material to be of adequate quality.

Magnetic and mechanical separation alone necessarily limit the attainable quality of the non-ferrous recovery. Stainless steel is not presently separated and will constitute an impurity. The aluminum content of the "light", non-ferrous recovery is over 70%. Reynolds Metal Company has indicated a desired minimum mesh size of No. 12 and an analysis shown in the first table in paragraph 5.2.1, which is typical of the Bureau of Mines system but was not a run of North Hempstead residue. Clear glass requirements of certain members of the Glass Container Manufacturers Institute are shown in Tables 5-1 and 5-2. While rigorous, these standards can be met in the proposed facility.

8.5 Administration

Operating costs are to be held to a minimum for the recovery plant to be economically viable. One way to keep these costs down in a facility like the North Hempstead proposed unit is to integrate the administration of both the incineration and the recovery plants. Common personnel can be utilized at a savings where reserve operators, maintenance men, truck drivers can divide their time between the two plants. The incineration plant's administration office would extend their responsibilities to include the operation of the residue recovery plant. The accounting, purchasing, and superintending functions would also control the latter facility.

While there would be overlapping functions between the two plants, the recovery facility will require a steady operating force. Tables 9-4 and 9-5 illustrate the minimum personnel required to operate 100 TPD and 150 TPD plants respectively. The wage rates indicated are in the lower quartile for the year 1972. An annual allowance is included to cover sales expense.

An independently run recovery facility would require a budget 15 to 20% higher than that shown in the aforementioned tables.

CHAPTER 9

ESTIMATED RESIDUE RECOVERY FACILITY COST

9.1 Capital Cost

The proposed 150 TPD residue recovery facility for North Hempstead has been estimated at approximately $1,400,000. Table 9-1 shows the breakdown of construction and equipment costs.

9.2 Annual Cost

The annual labor cost analyses for the same facility, run at 100 TPD and at 150 TPD, are shown in Tables 9-4 and 9-5 respectively. The increase in labor cost is closely proportional to the 50% increase in manpower required to operate the plant at 150 TPD rather than 100 TPD. In other words, increased capacity reduces only slightly the labor cost per ton of residue processed.

The annual operating costs for the alternate recovery phases are indicated in Tables 9-2 and 9-3. Noticeably, increased capacity reduces the operating cost per ton from $10.36 per ton for a 100 TPD plant to $9.20 per ton for operating at full production rate of 150 TPD.

Parameters will be current and future markets for non-ferrous metals and glass, and other economic considerations such as landfill savings, transportation options, and production costs.

9.3 Partial Recovery

Similar estimates have been computed for plants of same input capacity but for partial recovery: a) ferrous metals only, and b) ferrous metals and non-ferrous metals. Allowance was made for these variables: plant size, manpower, maintenance and ammortization costs. Table 9-6 indicates the resulting capital costs and operating dollars per ton values. These estimates are intended to present alternates to a complete residue recovery facility.

To be considered in the selection of a partial recovery facility is the possibility for expansion at a future date for non-ferrous metal and glass separation.

TABLE 9-1

PRELIMINARY CAPITAL COST ESTIMATE

150 TPD RESIDUE RECOVERY FACILITY

SUMMARY

1.	Structural Excavation	$ 10,000
2.	Sitework, Landscaping, Paving	40,000
3.	Piles	72,000
4.	Concrete	75,000
5.	Structural Steel	72,000
6.	Architectural	150,000
7.	Equipment	540,000
8.	Process Piping	33,700
9.	Plumbing	18,000
10.	Heating, Ventilating and Air Conditioning	28,100
11.	Electrical	79,000
12.	Instrumentation	30,000
	Sub-Total	$1,147,800
13.	Contingency, Engineering, & Misc.	210,000
	Total	$1,357,800

Note: Not included in above total are the costs of land and outside utility lines

TABLE 9-2

ANNUAL OPERATING COST ESTIMATE
150 TPD RESIDUE RECOVERY FACILITY

100 TPD OPERATION - 2 SHIFTS PER DAY

1. Direct Labor: (Table 9-4)		$182,400
2. Raw Materials:		
Flocculant ($1.60/lb)	$ 1,100	
Ferrosilicon ($0.07/lb)	100	
Replacement rods for grinding ($.12/lb)	1,100	
Replacement parts for hammermills	15,000	
Screens, pump parts, replacement parts, maintenance	3,000	
		22,200
3. Utilities:		
Electric power	17,600	
Water	1,000	
Natural gas	6,000	
		24,600
4. Fixed Charges:		
Insurance	12,000	
Amortization (30 yrs, 5-1/4%)		
Building (.067 x $700,000)	46,900	
Equipment (.067 x $540,000)	36,200	
		95,100
TOTAL		$324,300

$$\text{Cost per ton} = \$\frac{324,300}{100 \times 6/7 \times 365} = \$10.37$$

TABLE 9-3

ANNUAL OPERATING COST ESTIMATE
150 TPD RESIDUE RECOVERY FACILITY

150 TPD OPERATION - 3 SHIFTS PER DAY

1. Direct Labor:		
(Table 9-5)		$267,200
2. Raw Materials:		
Flocculant ($1.60/lb)	$ 1,600	
Ferrosilicon ($0.07/lb)	100	
Replacement rods for grinding ($.12/lb)	1,500	
Replacement parts for hammermills	22,500	
Screens, pump parts, replacement parts, maintenance	7,500	
		33,200
3. Utilities:		
Electric power	26,400	
Water	1,500	
Natural gas	9,000	
		36,900
4. Fixed charges:		
Insurance	12,000	
Amortization (30 yrs, 5-1/4%)		
Building (.067 x $700,000)	46,900	
Equipment (.067 x $540,000)	36,200	
		95,100
TOTAL		$432,400

$$\text{Cost per ton} = \$\frac{432{,}400}{150 \times 6/7 \times 365} = \$9.21$$

TABLE 9-4

ANNUAL LABOR COST ANALYSIS

RESIDUE RECOVERY FACILITY

PROCESSING 100 TPD - 2 SHIFT OPERATION

Job Classification	Shift 8 - 4	Shift 4 - 12	Total Men	Rate $/Year	Extension $/Year
Foremen	1	1	2	11,000	22,000
Scale Operators	0	1	1	9,300	9,300
Product Truck Drivers	1	1	2	9,300	18,600
Operators	2	2	4	8,800	35,200
Laborers	1	1	2	8,100	16,200
Shipping & Clerical	1	0	1	8,100	8,100
Maintenance	1	0	1	9,300	9,300
Total	7	6	13		$118,700
Fringe Benefits 28% of $118,700					33,300
5-day Week Annual Labor Cost				Total	$152,000
6-day Week Annual Labor Cost (1.20 x $152,000)				Total	$182,400

Process Rate = 6.25 TPH
2-Shift, 6-day week process (7-day week receiving)

TABLE 9-5

ANNUAL LABOR COST ANALYSIS

RESIDUE RECOVERY FACILITY

PROCESSING 150 TPD - 3 SHIFT OPERATION

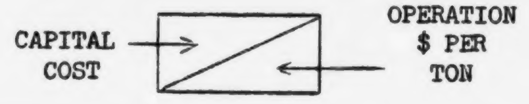
Job Classification	Shift 8-4	Shift 4-12	Shift 12-8	Total Men	Rate $/Year	Extension $/Year
Foremen	1	1	1	3	11,000	33,000
Scale Operators	0	1	1	2	9,300	18,600
Product Truck Drivers	1	1	1	3	9,300	27,900
Operators	2	2	2	6	8,800	52,800
Laborers	1	1	1	3	8,100	24,300
Shipping & Clerical	1	0	0	1	8,100	8,100
Maintenance	1	0	0	1	9,300	9,300
Total	7	6	6	19		$174,000
Fringe Benefits 28% of $174,000						48,700
5-day Week Annual Labor Cost					Total	$222,700
6-day Week Annual Labor Cost (1.20 x $222,700)					Total	$267,200

Process Rate = 6.25 TPH
3-shift, 6-day week process (7-day week receiving)

TABLE 9-6

RESIDUE RECOVERY FACILITY

SUMMARY OF PLANT AND OPERATIONS COSTS


CAPITAL COST
OPERATION $ PER TON

OPERATION (6 DAY WEEK)	RECLAMATION PROCESS		
	FERROUS NON-FERROUS GLASS	FERROUS & NON-FERROUS	FERROUS ONLY
2 SHIFTS 100 TPD	1,357,800 10.37	1,061,600 8.30	919,700 6.90
3 SHIFTS 150 TPD	1,357,800 9.21	1,061,600 7.44	919,700 6.10

CHAPTER 10

INCOME, SAVINGS AND OTHER BENEFITS FROM RESIDUE RECOVERY FACILITY

10.1 Income

10.1.1 Ferrous Metals

On the basis of price fluctuations in the previous 20 years, we predict a minimum range of \$20 to \$28 per long ton for the future price of No. 2 bundle scrap[1], \$20 being the absolute minimum future price. Prices quoted tentatively for our material by certain users at today's market conditions range from \$21 per net ton to \$28 per long ton. ISISI[2] predicts that market prices for No. 2 bundles would actually oscillate in a higher range of \$26 to \$29 per long ton (bottom); thus the \$23 per net ton price would be a reasonable average to assume, since it is impossible at this time to calculate the exact price adjustment for metallurigical inferiorities of the material.

For multiple car shipments of briquetted material, transportation costs are \$10.93 per net ton loose to a facility such as the Weirton plant in Pennsylvania yielding a net selling price of \$12.07 per ton of ferrous, delivered.

10.1.2 Non-ferrous Metals

The non-ferrous metal fraction can be marketed in two components, heavy non-ferrous and aluminum. The price for the aluminum fraction would be expected to range from \$120 to \$300 per ton, at North Hempstead. The average price of aluminum scrap over the last 20 years has been \$202 per ton. The income predictions for aluminum in this report are based on a price of \$200 per ton, net selling price at North Hempstead.

A reliable market may exist for the mixed heavy non-ferrous, without further segregation into copper, zinc, lead and smaller percentage constituents. A price comparable to the price of copper, or possibly aluminum, might be expected, but an income only one-half that of aluminum per ton is assumed from this source in evaluating the feasibility of the pilot plant because no specific positive buyer responses have been obtained.

10.1.3 Glass

The three glass manufacturers who have expressed a willingness to purchase the clear glass residue in the future will each accept 6 TPD, or

---

[1] See Figure 5-2.

[2] Miller, Jack Robert. "Scrap, Prereduced Iron Ore, and Electric Furnace Steelmaking in the 1970 Decade". Facts (31 Ed.), Institute of Scrap Iron and Steel, Inc., Wash., D.C., 1970, p. 87.

TABLE 10-1

CLEAR GLASS

RELIABLE INCOME PER TON

Market Location	Daily Tonnage	Selling Price ($/Ton)	Transportation ($/Ton)	Net Selling Price ($/Ton)
Jersey City, N.J.	6	15.00	3.75	11.25
Wharton, N.J.	6	15.00	6.90	8.10
North Bergen, N.J.	6	12.00	3.75	8.25
Average				9.20

approximately one-third of the daily residue output of the plant operating at its 2-shift capacity. Twelve tons daily are expected to market at $15.00/ton and six tons at $12.00/ton.

Transportation costs vary depending upon the plant location. The nearest plants, in Jersey City and North Bergen, can be reached most economically by renting a truck on an hourly basis. Two trips per day are feasible and a transportation cost as low as $3.75/ton can be expected. The other locations are handled most economically on a contract basis per trip and an approximate transportation cost of $6.90/ton is expected. This figure takes into account the possibility that trucks may make the trip one-way empty for one-half the trips, in agreement with local trucking experience. Table 10-1 shows the market prices, transportation costs and net selling prices tabulated, and it can be seen that the net selling price for clear glass averages $9.20/ton. This favorable net selling price is reached particularly because of the favorable price and transportation rates combining at the Metro Containers' Jersey City plant location, giving a net selling price to that location of $11.25 per ton.

There are no commitments involving financial return on colored glass, and no income is assumed in evaluating the economic feasibility of the residue recovery plant. At present, it is only expected that the colored glass fraction will be picked up free of charge, the user bearing the trucking cost. This will save on landfill costs and provide environmental benefits. The fraction is produced anyway as a result of clear glass separation and there is no reason not to use it. Perhaps experimentation in its use will result in markets yielding a net return after transportation.

10.1.4 Sand and Ash

In spite of its potential uses, as discussed in Chapter 5, sand does not yet have any specific buyers who will express an interest in future purchase, even though a firm commitment is not required. Therefore no income from sand is assumed in evaluating the economic feasibility of this project. This does not mean, however, that income from the sand fraction is out of the question. Even if buyers are unavailable, and the Town itself has no use for the material, potential users who will haul the material away free of charge should be sought.

Users or buyers for the ash from siftings and residue have not been located, and no income is assumed.

10.1.5 Total Income

A reliable income can be predicted from the ferrous, non-ferrous (separated into aluminum and mixed heavy non-ferrous metals) and clear glass fractions of the recovered residue. The net return for ferrous metal will range from $7 to $14/gross ton; aluminum, $120 to $300/ton; mixed heavy non-ferrous, $0 to $200/ton; and clear glass averages $9.20/ton. The clear glass income represents completely firm commitments from three companies, and the actual average return is figured on Table 10-2. A net return of $12.07/ton is used to predict ferrous income; $200/ton to predict aluminum income; $100/ton to predict heavy non-ferrous income; and $9.20/ton, clear glass income.

TABLE 10-2

RELIABLE INCOME FROM ONE TON OF RESIDUE

	Selling Price* ($/Ton)	Transportation ($/Ton)	Net Selling Price ($/Ton)	Weight of Component from One Ton Residue (T)	Net Return On Component From One Ton Residue ($)
Ferrous					
minimum	20/GT	10.94	6.91/NT	.304	2.10
maximum	28/GT		14.06/NT		4.27
predicted average	23/NT		12.06/NT		3.67
Aluminum					
minimum	120	-----	120	.006	0.72
maximum	300		300		1.80
predicted average	200		200		1.20
Mixed Heavy non-ferrous					
minimum	0	-----	0	.006	0
maximum	200		200		1.20
predicted average	100		100		0.60
Clear Glass					
predicted	[see Table 10-1]		9.20	.213	1.96
Total Income					
minimum					4.78
maximum					9.23
predicted average					7.43

*Net after selling expense

The total income per ton of residue is estimated on the basis of 30.4% ferrous metal, 0.6% aluminum, 0.6% mixed heavy non-ferrous, and 21.3% clear glass, all by weight. The ferrous from one ton of residue will net $3.67, the aluminum $1.20, the mixed heavy $0.60, and the clear glass $1.96. A total income per ton of residue, without marketing colored glass, sand, or ash, of $7.43 can be predicted, by marketing 52.9%, by weight, of the recovered residue. Table 10-2 summarized these predictions.

10.2 Savings

10.2.1 Landfill Required, Without Incineration

Without incineration, the refuse that would have been reduced in a facility of the practical capacity of the Hempstead Harbor refuse disposal plant would accumulate in landfill at a rate of 506 acre-ft/yr, or 12.6 acres/yr. Combined with the amount which can be handled by the Denton Avenue plant, this amount is increased to 691 acre-ft/yr, or 17.2 acres. Actually, the demand for incineration is greater than the plant capacity, and the 247,000 tons of refuse collected by the Town during 1971 and sent to the Hempstead Harbor and Denton Avenue sites,[1] if entirely unincinerated, would accumulate at a rate of 753 acre-feet/year.

10.2.2 Landfill Required for Residue, Without Recovery

Although incineration is the most efficient, proven reduction technique of solid waste processing, even the residue left by this 80% weight reduction process results in a landfill problem of some financial magnitude in an area of scarce and expensive land as in North Hempstead. At normal operation, the Hempstead Harbor incinerator can be expected to produce a yearly average of 90 TPD of residue, consuming 41 acre-feet per year, or an acre per year. The Denton Avenue plant is capable of contributing enough residue volume to bring the total landfill required for residue to 1.4 acres per year. All of the acreage values in this report pertaining to North Hempstead are based on an average fill height of 40 feet, on new land.

10.2.3 Landfill Reduction with Recovery of Residue

If all of the residue generated by the Hempstead Harbor incinerator is reclaimed and marketed, an acre of land per year will be saved. A substantial landfill savings can be achieved by marketing ferrous residue, non-ferrous, clear or colored glass, or sand and ash, alone or in combination. An increase in 37.5% in these landfill savings can be achieved by processing all of the residue produced by the Denton Avenue plant. The values for the more feasible of these possibilities are compared on Table 10-3.

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[1] Certain classifications such as demolition waste and rubbish go to other landfills.

TABLE 10-3

LANDFILL SAVINGS RESULTING FROM RECYCLING RESIDUE

	COMPONENT RECYCLED									
	(1) Ferrous	(2) Non-Ferrous	(3) Glass			(4) Sand	(5) Ash	(1) & (2)	(1),(2) & (3a)	Total (1)thru(5)
			Clear	Color	Total					
Percent of total by weight (%)	30.4	1.2	21.3	16.4	37.7	18.2	10.4	31.6	52.9	97.9
Roslyn										
Amount (TPD)	27.4	1.1	19.2	14.8	33.9	16.4	9.4	28.4	47.6	88.1
Acre-feet/year	12.4	0.5	8.7	6.7	15.4	7.4	4.2	12.9	21.5	39.9
Acre/year	0.31	0.01	0.22	0.17	0.38	0.19	0.11	0.32	0.54	1.00
Roslyn plus Denton Avenue										
Amount (TPD)	37.6	1.5	26.4	20.3	46.7	22.5	13.4	39.1	65.5	121.1
Acre-feet/year	17.0	0.7	11.9	9.2	21.1	10.2	5.8	17.7	29.6	54.8
Acre/year	.43	.02	.30	.23	.53	.26	.15	.44	.07	1.38

10.2.4 Land Cost

Only one residue disposal site located at a practical haul distance will be available upon completion of the landfill behind the dike at the Hempstead Harbor refuse disposal plant. This new site is located in the depleted sand pits on the west shore of Hempstead Harbor about 1-1/2 miles north of the disposal plant. This land is priced at $75,000 per acre. It consists of relatively level land backed by a 130 ft high escarpment. It is on the basis of sloping the fill from approximately grade level at the road to a plateau of 80 or 100 ft elevation at the escarpment that the 40 ft average fill height is derived. This gives a landfill cost of $1,875 per acre-ft.

If the U.S. Army Corps of Engineers approves the construction permit application for the new dike, 900 acre-feet will be made available when the $800,000 dike construction is complete. This will amount to $890 per acre-foot of disposal volume. The figures for landfill savings in this report are not based on utilizing the $890 cost per acre-foot, but, rather, on the sandpit landfill cost.

10.2.5 Annual Landfill Cost Savings

Marketing of the ferrous, glass or sand fractions from residue offers a prospect for modest landfill savings in acreage, and substantial land cost savings at the land values in proximity to the incinerator. If the three most marketable residue components, ferrous, non-ferrous and clear glass, are recycled, annual land cost savings in connection with disposal of the residue from the Hempstead Harbor plant will be approximately $40,000. Marketing of the residue components from Denton Avenue will increase this savings to $55,000 annually. Landfill cost savings appear on Table 10-4.

10.2.6 Landfill Savings per Ton of Residue Processed

Each ton of residue totally recovered and marketed represents a savings of two cubic yards of landfill space, valued at $2.32. Dollar savings in landfill volume achieved by marketing the ferrous, non-ferrous, and clear glass fractions of one ton of processed residue are approximately $.71, $0.03 and $0.50, respectively. These savings must be combined with the net selling price for the recovered fraction per ton of residue processed, and compared with the cost invested for one such ton. Landfill savings per ton of residue processed, for the most feasible marketing possibilities, appear on Table 10-5. If local landfill becomes unavailable, and barging is involved, these costs would increase.

Additional savings also result from reduced landfill operating costs. The cost to the Town of hauling, spreading and covering the residue amount to approximately $1.50/cu yd. If ferrous, non-ferrous and clear glass are eliminated from each ton of residue spread on the landfill, an operating cost savings of $1.59 per ton of residue is achieved. Land cost savings of $1.23 (Table 10-5) combined with landfill operating cost savings of $1.59 yield a savings of $2.82 per ton of residue processed.

10.2.7 Savings Plus Income

Total economic benefits appear in Table 10-6, combining net return on sales, landfill operating costs and land costs. The average net returns from Table 10-2 are used. If ferrous, aluminum, heavy non-ferrous and clear glass are marketed, the total of income and savings combined will be $10.16 per ton of residue processed.

TABLE 10-4

ANNUAL LANDFILL COST SAVINGS RESULTING FROM RECYCLING RESIDUE

Component Recycled	Savings/Year ($/Yr)	
	Roslyn	Roslyn plus Denton Ave.
(1) Ferrous	$23,200	$31,900
(2) Non-ferrous	900	1,300
(3) Glass		
(a) Clear	16,300	23,400
(b) Colored	12,500	17,200
Total	28,800	39,600
(4) Sand	13,900	19,100
(5) Ash	7,900	10,900
(1) and (2)	24,100	33,200
(1), (2) & (3a)	40,400	55,200
Total (1) thru (5)	74,700	102,800

TABLE 10-5

LANDFILL SAVINGS PER TON OF RESIDUE PROCESSED

Component Recovered	Weight of Component From One Ton Residue (T)	Savings* ($)
(1) Ferrous	.304	$0.71
(2) Non-ferrous	.012	.03
(3) Glass		
(a) Clear	.213	.50
(b) Colored Glass	.164	.38
Total	.377	.88
(4) Sand	.182	.42
(5) Ash	.104	.24
(1) & (2)	.316	$ .73
(1), (2) & (3a)	.529	$1.24
Total (1) thru (5)	.979	$2.28

*Operating cost savings not included

TABLE 10-6

RESIDUE RECOVERY

TOTAL BENEFITS - ECONOMIC ANALYSIS*

INCOME PLUS LANDFILL SAVINGS PER TON OF RESIDUE PROCESSED

Component Recovered	Net Return (average)	Landfill		Total Income plus Landfill Savings
		Land Cost Savings	Operating Cost Savings	
Ferrous	$3.67	$0.71	$.91	$5.29
Non-Ferrous				
Aluminum	1.20	0.015	.018	1.233
Heavies	0.60	0.015	.018	.633
Clear Glass	1.96	.50	.64	3.10
Total	7.43	1.24	1.59	10.26

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*Environmental factors, discussion following, are not assigned monetary values.

10.3 Other Benefits

Many of the benefits of residue recovery fall into the category of "intangibles"; those factors for which a dollar-and-cents value cannot be assigned. In fact, those benefits which initially elicited public demand for recycling, of which residue recovery is an off-shoot, are the very factors that cannot be defined in a concise economic way.

10.3.1 Conservation of Raw Materials

A national policy of recycling was envisioned by conservationists both to conserve valuable resources such as mineral ores for future generations and to preserve the face of the land, which is often strip-mined to release raw materials. Residue recovery practiced on a significant scale would reduce the consumption of certain virgin ores, those from which iron, aluminum, copper and zinc are produced. This is particularly important in modern mining practices, where low grade ore is increasingly exploited. For instance, in the modern practice of taconite mining in the north central United States, ore grade varies from about 30 to 39% Fe. Thus, assuming complete iron recovery from the ore, a ton of ferrous recovered from residue would replace about three tons of ore.

Recovery of glass and sand from residue would cause a small reduction in open pit mining for the raw material sand in such locations as Long Island.

10.3.2 Local Environmental Problems

The problem of disposal of incinerator residue has provided local keynotes for two of Long Island's biggest environmental problems. The necessity to enlarge the residue disposal area into Hempstead Harbor, constructing a dike to contain the material, brought into local focus the problem of ever-diminishing wetlands around Long Island. Furthermore, the most likely disposal site offered as a solution to this ecological threat, the sand pit area, touched on the problem of contaminant seepage into groundwater, Long Island's very critical resource which is in recent years subject to great controversy without any particular contributing factors. Solutions offered to the public by officials - the creation of substitute wetlands, or in the second case, effective groundwater barrier - do not quell public suspicions.

10.3.3 Land Use Planning

Although it is true that solid waste disposal is a vital land use, it would certainly be preferable to residents and business alike if space occupied by landfill occupations could be freed for other uses. The sanitary problems long associated with refuse disposal landfill operations have given landfills connected with solid waste the stigma of being an undesirable land use. The possibility exists of utilizing land in terms of its economic return and phasing out or reducing landfill operations to substitute commercial development, where taxes would be returned to the community. Besides the most common land uses locally, residential development or commercial purposes, for which land could be freed, the potential exists to free land for open space purposes for public benefit.

CHAPTER 11

LEGAL AND ADMINISTRATIVE

Placing a public agency in a position to efficiently market products will require revisions in existing laws and auditing practices. Existing practices are largely designed to prevent malfeasance in selling publicly owned goods. Such controls are obviously necessary in the marketing of used equipment, surplus material, land and similar public property. With residue, the Town will be dealing with essentially a waste material which would have heretofore had a negative value. When the Town relieves itself of a product with a negative value, the Town and related public interest benefits. The following discussion outlines the principal legal and administrative modifications needed:

11.1 Existing Authority

Authority for the Town to sell public property derives from Section 29, Article 3, paragraph 11. The powers and duties of the Supervisor permit him, "to leave, sell and convey, in the name of the Town, property owned by it, whenever and in the manner authorized by the provisions of this chapter or any other general or special law and shall execute and deliver, in the name of the Town, grants of easements or other rights in lands or other property owned by the Town, whenever so directed by the Town Board". The State Comptroller has ruled in his Opinion 70-1002 that a Town may sell unneeded Town property at private sale, subject to a permissive referendum. It is not certain at this time whether the property referred to in the preceding sentence relates to real property or, as in this case, recovered products from residue.

It appears, therefore, that a ruling will have to be obtained from the State Comptroller as to the Town's position in a private sale of recovered products. By private sale the Town would be able to negotiate directly with any prospective purchaser without the necessity of cumbersome advertising and public bidding. This is the method employed by dealers in secondary materials. The Town would have to be empowered to act in a similar manner if it were to proceed efficiently.

11.2 Selling, Pricing and Quantity Incentives and Controls

The responses obtained from the steel and glass industries indicate that sales contracts could be reasonably contemplated for at least one year, possibly two to three years, but probably not any longer. During the study, incentives and controls for assisting in the stabilization of the price of such materials were considered but the reluctance of typical industry segments to commit themselves on a long term basis would appear to inhibit the use of such incentives. The best incentive to encourage private industry to participate in long term contracts would have to include a price adjustment feature. The judgment of marketing specialists is that such an adjustment feature and the related formulas would necessarily depend on one or two years experience in handling recovered residue.

Consequently it is impractical to set up any meaningful procedure without such experience.

A demonstration project would provide an excellent reservoir of information on how adjustments can be suited to market conditions and give the Town the desired ability to dispose of residue at the best available price within a selected time interval.

11.3 Quality and Quantity Purchase Agreements

Quality and quantity purchase agreements relate to the marketing flexibility. The Town must be in a position to literally and figuratively bargain at arm's length with potential receivers. The Town's selling agent will have to make a judgment as to what market fluctuations are likely to be and whether it is in the Town's interest to make a commitment to a particular supplier on a long term basis, with a possible suffering of a loss of revenue should the price go higher. As in any private business, it is necessary to recognize that an opportunity for wrongdoing will exist in such a negotiating atmosphere. To the extent practicable there should be a full record of negotiations, including a statement by the Town's salesman regarding his reasons for approving or disapproving any proposed contract terms. The real measure of success is the result obtained for the Town in moving the recovered material out of the Town and the gross revenue returned.

11.4 Effects of Bidding vs Negotiation Procedures

Bidding has the advantage of public advertisement, written quotations, sureties and other evidence of responsibility. Its disadvantages are that it requires a certain amount of overhead for the purchaser and it requires the preparation of a proposal in advance both of which, to a certain extent, inhibit the purchaser's flexibility. Negotiation overcomes the disadvantages from the purchaser's viewpoint but does leave the Town open to problems of failure to disseminate information, disgruntled would-be purchasers and the ever present possibility of wrongdoing. The demonstration project would be an excellent laboratory for trying both procedures. Such a test run should go far to determine where the advantages reside for achieving the Town's goal of efficient marketing.

11.5 Auditing Procedures and Auditing Formats

Procedures and formats for effective auditing will be needed to record all steps in the disposal of residue products. This would include notification and communications with prospective purchasers, details of negotiation, method of measurement, independent verification of measurements, collection of amounts due the town and, most important, fixing of terms of price and delivery.

11.6 Forms of Contract and Purchase Agreement

The preliminary formulation of possible contracts would be based on the proposals received from glass and ferrous metal industry segments. During the demonstration study extensive discussions between the Town and potential market sources would be utilized to determine the most suitable forms for such documents. Initially it appears practicable to do all of this on a simple letter basis. This would entail the prospective purchaser examining samples of the material at a Town location and then submitting a written quotation to the negotiator, offering to purchase a specific quantity at a specific price and time of delivery based on the sample. What such a procedure would attempt to do is to achieve as nearly as possible a rapid responsible wholesale market operation. The goods are placed on display, the purchaser negotiates with the salesman and then as quickly as possible arranges to remove the purchased materials.

APPENDIX A

MARKETING STUDY - JAMES FLETT ORGANIZATION - CONCLUSIONS

February 1972 - James Flett Organization

FERROUS SCRAP PRICING

Ferrous scrap prices continue at a low level with slight improvement in the last 30 days and some indications of increased volume and, possibly, additional improvement within another 60 days. The current market is firm and active with renewed interest in the export field.

In our opinion the 1971 market for #2 bundles went to about as low a level as is possible. Any further decline in prices would probably reduce the supply below the level necessary to complete commitments to the mills. This low was $20.84 composite average during November - December 1971.

For the longer term the outlook is encouraging. Steel producers are adopting the continuous casting process to replace ingot pouring. One major producer is adding electric furnace capacity to an Eastern plant. Both these factors will require more purchased scrap.

Our government's monetary policy should make domestic steel more competitive with imported steel. Imports for 1971 are estimated by American Metal Market at 18 million tons. If this had been added to the 125 million tons of domestic production, the total would almost equal domestic steel's record of 145 million tons in 1969. The normal population growth and the continuously rising standard of living increase the consumption of steel. This is partically offset by increased generation of scrap but since the average life cycle for steel exceeds 20 years increased scrap lags behind in the absence of a drastic decline in sales.

The continuous casting process is significant to generators of incinerator residue scrap. This process produces far less home scrap than does ingot pouring. One of the principal objections to incinerated scrap is that residual copper builds up by contaminating the home scrap. Obviously, if there is less home scrap made, the buildup will be reduced.

We hope for recovery of prices but feel that it is unlikely that prices for #2 bundles will exceed the 1970 high of $28.64 within the next two years.

THE EFFECT OF RECYCLING ON FERROUS SCRAP PRICES

Widespread magnetic separation of scrap from unincinerated solid waste does not appear to be an attainable goal within the immediate future. This method has been practiced in the past, but in the Northeast it is virtually unknown. Western cities, noticeably Los Angeles and San Francisco, can take advantage of their short haul to the copper refiners and operate profitably.

This is the direction taken by the major steel companies and their affiliate, The American Iron and Steel Institute. At present they are initiating a program at a garbage transfer station in Allegheny County, Pa. Local garbage trucks bring their loads to the transfer station. It is then loaded in large trailers and dumped in nearby abandoned mines, quarries, etc. The Institute proposes to separate ferrous metal from the refuse magnetically, wash or lightly burn this and return it to a nearby steel mill. Supposedly, if this operation is a success, it will be expanded to other municipalities. If it cannot be made to work here, in the shadow of a concentration of steel mills, then it probably won't succeed anywhere else.

The total steel consumption by the packaging industry is about 8% of domestic production. At present this totals more than 9,000,000 tons of steel, about 25% of last year's estimated consumption of purchased scrap. An estimated 20% of this is already coming back as scrap from the container manufacturer and from the detinning plants. This still leaves a potential of over 7-1/2 million tons that might be recovered from waste. We think that it is safe to say that this enormous quantity of scrap could not be absorbed by the industry at any price.

Recycling incinerated steel appears much more favorable. Since approximately 8% of all solid waste is incinerated, this reduces the potential volume to approximately 600,000 tons a little less than 2% of all purchased scrap, if every incinerated can were recycled.

At this moment, National Steel Corporation appears very anxious to have this material. Within the last month they have completed experiments in using incinerated ferrous scrap to make iron. They are very enthusiastic about this and they feel that this practice will become general with the industry within a short time. Further conferences with National Steel's executives are scheduled for the purpose of discussions as to preparation of incinerated steel scrap, including the possibility of having nearby incinerators ship additional scrap through our plant for preparation. F.E. Tucker, V.P. assures me that his home plant alone can use our projected monthly capacity in 6 days.

So far as we can determine, the major steel companies intend to use unincinerated cans in their steel furnaces. Unincinerated cans will be graded as #2 bundles.

Incinerated cans sold to National Steel Corp. will not be used in their steel furnaces. Therefore, the two types of can scrap are not directly competitive, even though we contemplate using the price structure of the #2 bundle.

The Institute of Scrap Iron and Steel has listed "Incinerated Can Bundles" as a separate grade of scrap at least as far back as WW II. We cannot find any history of sales of this grade or any published quotations within the last decade. Widespread recycling would probably bring this classification back into use.

As of this writing, recycling of cans is not a factor in scrap pricing.

CONCLUSION

We appear to have a satisfactory market for our total production of ferrous scrap. In National Steel Corp. we think we have found a consumer willing to cooperate to the fullest degree and able to use far more incinerated steel scrap than we can produce.

We think it reasonable to expect that as National's blast furnace usage is developed and improved the market will expand. Since the blast furnace manufactures iron, this may be particularly attractive to mills who do not own iron ore and to mills that are paying long-haul freight charges for iron ore.

Additional markets remain to be explored.

RECYCLING OF NON-FERROUS SCRAP

The basic non-ferrous produced by the Bureau of Mines process is aluminum. But it is always in a contaminated form. Much pure aluminum scrap is returned to the primary manufacturers and is fed back into the production cycle with little or no difficulty.

As far as we can determine Reynolds Metals is the only primary producer working with contaminated material in the East. However, there are many smaller, secondary refiners who purchase aluminum scrap for smelting and sell refined, high grade aluminum, mostly for foundry use. They can manufacture and sell such aluminum at prices lower than those of the primary manufacturers.

In recycling, aluminum is produced by the voluntary recycling programs sponsored by the can manufacturers, soft drink producers, and charity organizations. Their volume figures, always expressed in millions of cans, are impressive. In terms of aluminum tonnage, it is our opinion that the volume is insufficient to effect the scrap market, especially so since at least one of the major producers of aluminum for cans uses the recycled material as a substitute for new aluminum rather than aluminum scrap. The experimental processes by Black-Clawson and by Bureau of Mines recover almost all of the aluminum in solid waste. It is extremely doubtful that this volume would have any depressing effect on the aluminum scrap market in the next two years.

The small volume of other non-ferrous scrap contained in solid waste makes this conclusion valid for all non-ferrous.

NON-FERROUS SCRAP PRICES

At present there is excess capacity for the manufacture of new aluminum. Between 1960 and the end of 1970, the supply of aluminum doubled, and is still rising. Shipments more than doubled.

Some of the principal markets for aluminum are the construction industry, transportation and packaging. The packaging industries use of aluminum is growing, the construction industry has shown improvement in recent months. It is expected that demand for aluminum will increase.

Aluminum scrap prices are now at the lowest level since 1947. It is possible that there could be further declines but it is unlikely that this could be substantial or of long duration. But cast scrap sold for 3.73¢ per lb. in 1945. We do not think that sufficient scrap would be available today at that level and suggest that it might not be at 5¢ per lb.

Nor do we feel that, within the next two years, will scrap prices reach the 1955 high of 15.34¢ per lb., unless some unexpected development creates unprecedented demand. We feel that within this period a general upturn in business may increase prices by about 25% to 30%.

CONCLUSIONS

We do not anticipate any difficulty in disposing of the major non-ferrous items generated by a Bureau of Mines separator plant. These are aluminum, zinc, and possibly copper. Markets for these materials fluctuate, but have always been very active.

Efforts should be made to determine our most advantageous marketing point, i.e., at what point in the separation process should the material be sold for futher refining. Based on present information, our opinion is that we should not sell a mixed non-ferrous. This would place us in a buyer's market in competition with the automobile shredders.

If the mixed non-ferrous is a step further into light and heavy fractions we will have greater competition among prospective buyers and, probably, more than enough revenue to support the added processing.

INCINERATOR RESIDUE GLASS PRICES

This material has never been commercially available so no price has ever been established.

In conversation with a spokesman for a major glass container manufacturer a price at the level of $10.00 - $12.00 per ton was discussed. This was arrived at by making a deduction for handling from the cost of their normal raw material. This figure should be used with caution. Our opinion is that a price somewhat lower than purchased glass cullet would be more realistic but I have not been able to determine this figure.

EFFECT OF RECYCLING ON GLASS MARKETS

We do not feel that voluntary recycling programs will effect the glass market. Nor do we foresee any mechanical separation process for solid waste that will produce sufficient volume to have any effect.

CONCLUSION (GLASS SCRAP)

No satisfactory solution to the disposal of glass incinerator residue material is at hand.

We feel that the glass container industry is making genuine efforts to solve the problems created by the large volume of waste glass going into municipal solid waste. We are critical of some of their public statements which we consider to be over optomistic and we feel that in the long run this tendency may be harmful in that it might lead the public to think that voluntary recycling will do the job. Actually, a very small percentage of the container glass used is recovered by voluntary recycling.

We also feel that searching for markets other than the container industry is chasing the will-o-the-wisp. The basic fact is that the raw materials from which glass is made, excluding freight, are so plentiful and so cheap that, unless some other incentive exists, our product is not going to be used. "Ban the non-returnable container" legislation has provided the essential incentive to the glass container industry.

No doubt the Town can, if they choose to, require the use of glass in the repair and construction of Town roads and streets.

One of the major container manufacturers has stated that they are interested in using the recovered incinerator glass at any plant where they produce amber glass provided that impurity content, principally aluminum, can be eliminated or reduced to acceptable levels. Our opinion is that this is the direction in which we should move.

RECOMMENDATIONS

We feel that we have assured markets for non-ferrous and ferrous scrap.

We feel that it is reasonable to expect that the quality of the glass scrap can be improved so that at least a portion of it can be sold, provided that sufficient quantities of material, produced under controlled conditions, are available. We feel that the glass container manufacturers will cooperate with us to make the product acceptable. Also, the industry is making an effort to develop other products where this material could be used.

Leading this list of tasks to be accomplished is the development of an acceptable glass. To do this, we must first confer with producers to determine exactly what contaminants must be reduced and to what level. If the industries specifications can be met, we will have no difficulty in marketing the glass in Northern New Jersey with minimal transportation problems.

For non-ferrous scrap, we should follow-up contacts with A.T. & T. and Reynolds Metals. Both of these companies are active in environmental control and we would expect that they would be willing to assist us in efforts to improve our product, for greater usability and increased revenue.

We do not expect major problems in transportation of this relatively high-priced material, but this point should be explored. Analysis of cost versus return of more advanced separation processes should be made.

For ferrous scrap, we should continue our investigation into the possibility of marketing at least a part of this material to other outlets. Having only a single outlet for a major production item is undesirable. The risk of strikes, fire, technological changes, etc., is acute.

Discussions regarding the preparation of this scrap for blast furnace use are already scheduled for next week. We favor extensive preparation for these reasons:

1. To increase value and reduce transportation charges.
2. To discourage competition.
3. To broaden the market.

We feel that a substantial investment in machinery to briquette this scrap should be made. We would like to further explore the foundry market which might be available if the material were briquetted. We do not feel that the mateiral can be sold to foundries unprepared.

It is essential that a complete investigation into the transportation problem be made.

We should continue discussion with steel mills closer at hand, making sure that they are aware of new developments.

It is now technically possible to remove or reduce the copper content of incinerated scrap. It is not economically feasible. We should be involved in these processes, perhaps in cooperation with the Bureau of Mines, the industry or the association.

It is not now possible to remove tin, but this has been studied by the detinning industry and the problem might be solved in the future.

APPENDIX B

SUMMARY OF CONTACTS ESTABLISHED

TABLE B.1

SUMMARY OF CONTACTS ESTABLISHED

Potential Markets for Residue Components - Ferrous

Company/Organization	Contact(s)	Letter	Telephone	Visit	Response Received	Information Furnished	
						General	Technical
Allegheny Ludlum Industries, Inc. Oliver Bldg. Pittsburgh, Penna. 15222	Mr. R.H. Henke, Vice Pres.	x			x		
American Iron and Steel Inst. 150 East 42 Street New York, N.Y. 10017	Mr. Alex Reeves, Jr. H&K Marketing Services Corp.		x	x	x	x	
American Standard, Inc. 40 West 40 Street New York, N.Y. 10018	Mr. W.H. Mansfield, Dir. of Procurement	x			x		
American Telephone & Telegraph Co. 195 Broadway New York, N.Y.	Mr. Horton, Env. Control		x		x		
Armco Steel Corp. 703 Curtis Street Middletown, Ohio 45042	Mr. C.W. Verity, Jr.	x					
Belmont Smelting & Refining Co 330 Belmont Avenue Brooklyn, N.Y.	Mr. Robert Henning Mr. Philip Nicola		x	x	x		
Bethlehem Steel Corp. Bethlehem, Pa. 18016	Mr. A.W. Connar, Vice Pres. Dr. D.J. Blickwede, Vice Pres. Research Mr. Lewis W. Foy Mr. T.V. Wainwright, Mgr. Research Mr. M.C. Cressman, Dir. Pur. Mr. J.J. Ferrigan, Ass't Gen'l Pur. Agent	x	x	x	x	x	x
Continental Can Co.	Mr. M.L. Smith		x				

Table B.1 Continued

Company/Organization	Contact(s)	Letter	Telephone	Visit	Response Received	Information Furnished	
						General	Technical
Continental Steel Corp. 1109 S. Main Street Kokomo, Ind. 46901	Mr. Arthur L. Miller	x					
Dresser Industries, Inc. 332 S. Michigan Avenue Chicago, Ill. 60604	Mr. F.L. Bredimus	x					
Ductile Iron Foundry, Inc. Honeyspot Road Extension Stratford, Conn.	Mr. Robert Jacob	x					
Florida Steel Corp. Box 1512 Tampa, Fla.	Mr. E.L. Flem	x					
Huron Valley Co. 12451 Haggerty Road Belleville, Mich. 48111	Mr. Leonard Fritz Mr. Mel Wallace		x		x	x	
Jacob Brothers, Inc. 1240 Seaview Avenue Bridgeport, Conn.	Mr. Robert Jacobs	x		x	x	x	
Jones & Laughlin Steel 3 Gateway Center Pittsburgh, Penna. 15230	Mr. William R. Roesch Mr. Edward Grau Mr. J. W. Lindsay	x	x		x		
Kaiser Steel Corp. 300 Lakeside Drive Oakland, Calif. 94612	Mr. John D. Saussaman, Vice Pres.	x			x		
Lone Star Steel Corp. 2200 Mockingbird Lane Dallas, Texas 75236	Mr. George A. Wilson, Pres.	x			x		
Luria Brothers Cleveland, Ohio	Mr. Dick Burlingame, Res. Dir.		x		x		
M & T Chemicals, Inc. A subsidiary of American Can Co. Rahway, N.J. 07065	Mr. D.B. Read Dir. of Sales Mr. McCauslan Mr. Lou Bielicki	x	x		x	x	
McWane Cast Iron Pipe Co. 1201 Vanderbilt Rd. Birmingham, Ala. 35204		x					

Table B.1 Continued

Company/Organization	Contact(s)	Letter	Telephone	Visit	Response Received	Information Furnished	
						General	Technical
National Rolling Mills Co. Marshall Rd. Malverne, Penna. 19355		x					
National Steel Corp. 2800 Grant Bldg. Pittsburgh, Penna. 15219	Mr. Fred. E. Tucker, Vice Pres., Env. Control Mr. E.J. Ostrowski, Div. Chief Process Metallurgy	x	x	x	x	x	x
Ogden Corp. 161 East 42 Street New York, N.Y. 10017	Mr. Ralph E. Ablon	x					
Phoenix Steel Corp. Claymont, Del. 19703	Mr. Clyde A. Roberts	x		x	x		
Pollack Steel Corp. P.O. Box 15237 Cincinnati, Ohio 45215	Mr. David Pollack	x					
Republic Steel Corp. Republic Bldg. Cleveland, Ohio 44101	Mr. W.B. Boyer	x					
Sharon Steel Corp. P.O. Box 291 Sharon, Penna. 16146	Mr. Walter E. Gregg	x					
U.S. Pipe and Foundry Co. 3300 First Ave. North Birmingham, Ala. 35202	Mr. R. Bates Wilson, Vice Pres., Eng. Mr. R.J. Rice, Res. Metal.-Burlington, N.J.	x	x		x	x	
U.S. Steel Corp. 600 Grant Street Pittsburgh, Penna. 15230	Mr. Frank Buchheit, Mgr. Process Material Handling Mr. W.W. Crawford Mr. J.O. Hawthorne, Res. Center - Monroeville, Pa.	x	x		x	x	
Washburne Wire Co. Phillipsdale, R.I. 02916	Mr. E.G. Pritchard	x					

Table B.1 Continued

Company/Organization	Contact(s)	Letter	Telephone	Visit	Response Received	Information Furnished	
						General	Technical
Wheatland Tube Co. Public Ledger Bldg. Philadelphia, Penna. 19106	Mr. John J. O'Donnell	x					
Wheeling Steel Co. Wheeling, W.Va. 26003	Mr. Donald E. Duval	x					
Wickwire Bros., Inc. 189 South Main St. Courtland, N.Y. 13045	Mr. Chester F. Wickwire	x					
Alan Wood Steel Co. Conshohocken, Penna.	Mr. Harleston R. Wood, Chrmn. Bd. & Pres. Mr. John J. Hannigan, Vice Pres.Operations	x	x	x	x	x	
Woodward Co. Woodward, Ala.	Mr. William R. Bond	x					

TABLE B.2

SUMMARY OF CONTACTS ESTABLISHED

Potential Markets for Residue Components - Non-ferrous

Company/Organization	Contact(s)	Letter	Telephone	Visit	Response Received	Information Furnished	
						General	Technical
Aluminum Association 750 Third Avenue New York, N.Y.	Mr. John C. Dale, Mgr. Env. Service Mr. Ted Gradin, Mgr. Statistics		x		x	x	
American Metal Markets Somerset, N.J.	Mr. Ted. Polansky, Secondary Materials Editor		x		x		
Belmont Smelting & Refining Co. 330 Belmont Avenue Brooklyn, N.Y.	Mr. Robert Henning		x		x		
J. R. Elkins, Inc. 518 Gardner Avenue Brooklyn, N.Y.	Mr. Joseph Elkins, Pres.		x		x	x	
Jacob Brothers, Inc. 1240 Seaview Avenue Bridgeport, Conn.	Mr. Robert Jacobs	x		x	x	x	
Luria Brothers Cleveland, Ohio	Mr. Dick Burlingame Research Director		x		x		
National Assoc. of Secondary Materials Industries (NASMI) 330 Madison Avenue New York, N.Y. 10017	Mr. Howard Ness			x			
The Ore & Chemical Corp. 235 East 42nd Street New York, N.Y. 10017	Mr. P.K. Falkenrath	x	x		x		
Reynolds Metals Company 6801 West Broad Street Richmond, Va. 23218	Dr. Robert F. Testin, Dir. Env. Planning	x	x		x	x	x

TABLE B. 3

SUMMARY OF CONTACTS ESTABLISHED

Potential Markets for Residue Components - Glass

Company/Organization	Contact(s)	Letter	Telephone	Visit	Response Received	Information Furnished	
						General	Technical
Anchor Hocking Corp. Lancaster, Ohio 43130	Mr. Charles J. Arnsberger, Dir. Public Affairs	x	x		x	x	x
Certain-Teed Products Corp. Valley Forge, Penna. 14981	Mr. M.J. Davis, Jr., Vice Pres.	x	x		x	x	x
Clemson University Clemson, So. Carolina	Prof. Gilbert C. Robinson, Ceramics Eng. Dept.	x			x		
Colorado School of Mines Research Institute P.O. Box 112 Golden, Colo. 80401	Mr. Cliff Shutt, Proj. Mgr. Chemical Division	x					
Glass Containers Corp. 535 North Gilbert Avenue Fullerton, Cal. 92634	Mr. George Keller	x					
Glass Container Mfs. Inst. 1130 Seventeenth Street, N.W. Washington, D.C. 20036	Mr. John H. Abrahams, Jr., Mgr., Env. Poll'n Control	x		x	x	x	x
Metro Glass Div. Kraftco P.O. Box 326 Jersey City, N.J. 07305	Mr. Robert Dreyfuss Tech. Dir. Mr. W.J. Bieryla	x	x		x	x	x
Owens-Corning Fiber Glass Barrington, N.J.	Mr. Richard Neal Pur. Mgr.		x		x		
Owens-Illinois, Inc. P.O. Box 1035 Toledo, Ohio 43601	Mr. John A.Minns, Mgr. Solid Waste Disposal Act.	x	x		x	x	x
Thatcher Glass Company Big Flats, N.Y. 14810	Mr. Thomas Mike Central Research Bldg.	x			x	x	x
University of Missouri-Rolla Rolla, Missouri 65401	Dr. Ward Malisch, Assoc.Prof.Civ.Eng.	x		x	x	x	x

APPENDIX C

SAMPLING AND TESTING DATA SHEETS

APPENDIX C.1

Refuse and Residue Tests at North Hempstead

(1)

REFUSE DELIVERED TO PIT

North Hempstead Incinerator
Roslyn Harbor

Date 10/19/71

Type of Waste:
Comm - Commercial
Res - Residential

Truck	Type of Waste	Time	Total Weight	Tare Weight	Net Weight: Lbs.
Grand Cart.	Commercial	7:10	34,220	27,000	7,220
J. Bauman	Commercial	7:45	12,980	9,400	3,580
D. Allen	Residential	8:05	31,720	20,900	10,820
V & J Rubb.	Commercial	8:18	31,840	25,000	6,840
Southside Ct.	Commercial	8:22	32,980	28,140	4,840
Republic Ct.	Commercial	8:30	39,960	24,900	15,060
J. Bauman	Commercial	8:33	13,000	9,400	3,600
Donno Co.	Residential	8:50	29,280	19,000	10,280
H. Anderson	Residential	8:57	32,620	22,400	10,220
Donno Co.	Residential	9:05	27,540	17,700	9,840
Donno Co.	Residential	9:12	20,940	14,600	6,340
Star Cart.	Residential	9:14	58,760	44,260	14,500
Gallagher Ser.	Residential	9:16	27,820	19,500	8,320
Donno Co.	Residential	9:19	21,360	13,800	7,560
Reshard Cart.	Residential	9:23	21,280	18,100	3,180
Vill. Westbury	Residential	9:25	31,800	19,300	12,500
Donno Co.	Residential	9:33	19,700	14,000	5,700
J. Bauman	Residential	9:38	11,900	9,400	2,500

REFUSE DELIVERED TO PIT

North Hempstead Incinerator
Roslyn Harbor

Date 10/19/71

Type of Waste:
Comm - Commercial
Res - Residential

Truck	Type of Waste	Time	Total Weight	Tare Weight	Net Weight: Lbs.
Southside Ct.	Commercial	9:51	27,640	20,640	7,000
Reshard Cart.	Residential	10:05	22,860	16,840	6,020
D. Allen	Residential	10:14	31,800	26,620	5,180
Donno Co.	Residential	10:17	26,140	22,400	3,740
Vill. Great Neck	Residential	10:27	27,960	18,800	9,160
Vill. Westbury	Residential	10:37	27,480	22,900	4,580
G & G Cart.	Residential	10:43	48,820	29,500	19,320
Donno Co.	Residential	10:46	14,100	9,600	4,500
Vill. Mineola	Residential	11:10	35,100	21,000	14,100
Gallagher Ser.	Residential	11:21	44,280	29,000	15,280
Donno Co.	Residential	11:26	20,460	14,600	5,860
Jamaica Ash	Commercial	11:35	34,820	25,600	9,220
J. Bauman	Residential	11:45	12,780	9,600	3,180
Vill. Mineola	Residential	11:48	30,700	21,000	9,700
Donno Co.	Residential	11:55	35,180	22,400	12,780
Vill. Williston Pk.	Residential	12:14	25,740	17,200	8,540
V & J Rubb.	Commercial	12:18	36,300	34,500	1,800
Southside Ct.	Commercial	12:21	36,980	27,100	9,880

REFUSE DELIVERED TO PIT

North Hempstead Incinerator
Roslyn Harbor

Date 10/19/71

Type of Waste:
Comm - Commercial
Res - Residential

Truck	Type of Waste	Time	Total Weight	Tare Weight	Net Weight: Lbs.
Donno Co.	Residential	12:35	31,420	20,400	10,820
V & J Rubb.	Commercial	1:00	33,660	30,000	3,660
Vill. Mineola	Residential	1:08	26,000	21,800	4,200
Donno Co.	Residential	1:45	18,060	13,300	4,760
J. Bauman	Commercial	1:50	24,180	14,840	9,340
Family Cart.	Residential	2:00	20,500	15,660	4,840
Donno Co.	Residential	2:12	25,120	19,000	6,120
Jamaica Ash	Commercial	2:15	31,700	25,600	6,100
Reshard Cart.	Residential	2:23	20,500	16,840	3,660
G & G Cart.	Residential	2:25	48,000	29,500	18,500
G & G Cart.	Commercial	2:38	23,680	18,400	5,280
Jamaica Ash	Commercial	3:06	41,220	25,000	16,220
Star Cart.	Residential	3:35	60,400	44,260	16,140

Residential	292,740	72.8%
Commercial	109,640	27.2%
	402,380	100.0%

TOTAL: 4,023.80 lbs.

or 201.2 tons

Incoming Solid Waste Composition Data

Field Sample

North Hempstead Incinerator
Roslyn Harbor

Date: 10-19-71

Time: 11:25 ±

TEST #1-A

	Component	Weight of container and waste (lb)	Container tare weight (lb)	Wet sample weight (lb)	Wet percentage*
Combustibles	Food waste	54	40	14	2.0
	Garden waste			100	14.2
	Paper products 1. Newsprint	90	40	50	7.1
	Corrugated 2. Boxboard			78	11.1
	3. Other Paper			211	29.9
	Plastics	48	31	17	2.4
	Rubber and Leather	40	33	7	1.0
	Textiles	60	31	29	4.1
	Wood	40	32	8	1.1
	Fines	92	41	51	7.2
			Sub-Total	565	
Noncombustibles	Metals 1. Ferrous			64	9.1
	2. Nonferrous	41	32	9	1.3
	Glass	70	42	28	4.0
	Ceramics			2	.3
	Ash, dirt, rocks	77	40	37	5.2
			Sub-Total	140	
	Total			705	100.0

$$\text{* Wet percentage} = \frac{\text{individual wet sample weight}}{\text{total wet sample weight}} \times 100$$

Comments:
COMBUSTIBLES 80.14%
NONCOMBUSTIBLES 19.86%

Incoming Solid Waste Composition Data

Field Sample

North Hempstead Incinerator
Roslyn Harbor

Date: 10-19-71

Time: 4:00 ±

TEST #1-B

	Component	Weight of container and waste (lb)	Container tare weight (lb)	Wet sample weight (lb)	Wet percentage*
Combustibles	Food waste			60	4.9
	Garden waste			147	12.0
	Paper products				
	1. Newsprint			119	9.7
	Corrugated 2. Boxboard			141	11.5
	3. Other Paper			292	23.8
	Plastics			44	3.6
	Rubber and Leather			6	0.5
	Textiles			119	9.7
	Wood			31	2.5
	Fines			25	2.0
			Sub-Total	984	
Noncombustibles	Metals				
	1. Ferrous			114	9.3
	2. Nonferrous			12	1.0
	Glass			75	6.1
	Ceramics			1	0.1
	Ash, dirt, rocks			41	3.3
			Sub-Total	243	
	Total			1227	100.0

$$\text{* Wet percentage} = \frac{\text{individual wet sample weight}}{\text{total wet sample weight}} \times 100$$

Comments:
COMBUSTIBLES 80.19%
NONCOMBUSTIBLES 19.81%

Incoming Solid Waste Density Determination

Field Data and Calculations

North Hempstead Incinerator
Roslyn Harbor

Date: 10-19-71

Time: 9:25 ± - TEST #1-A

Container No.	Weight of 55-gal container and waste	Container tare weight	Weight of waste	Density* of waste (lb/cu yd)
A-38	106	35	71	263
A-21	66	41	25	93
A-16	106	34	72	267
A-38	73	35	38	141
A-11	82	40	42	156
A-38	57	35	22	81
A-21	87	41	46	170
A-11	71	40	31	115
A-16	91	34	57	211
A-38	84	35	49	181
A-11	95	40	55	204
A-21	87	41	46	170
A-38	49	35	14	52 (**)
A-16	65	34	31	115
A-11	50 (**)	40	10	37
A-38	81	35	46	170
A-21	109	41	68	252
GRAND TOTAL			723	
Average	82	(***) 37.5	46.6	173

* Where Density = $\frac{\text{Weight of waste}}{\text{Volume of container}}$

Comments:
(**) Disregarded
(***) Ave. of A-16, 11, 38, 21

Sheet 1 of 2

Incoming Solid Waste Density Determination

Field Data and Calculations

North Hempstead Incinerator
Roslyn Harbor

Date: 10-19-71

Time: 4:00 PM

TEST #1-B

Container No.	Weight of 55-gal container and waste	Container tare weight	Weight of waste	Density* of waste (lb/cu yd)
A-21	121	41	80	296
A-38	78	35	43	159
A-20	108	42	66	244
A-21	99	41	58	215
A-38	77	35	42	155
A-20	98	42	56	207
A-11	102	40	62	230
A-38	71	35	36	133
A-21	101	41	60	222
A-11	107	40	67	248
A-20	111	42	69	256
A-20	89	42	47	174
A-11	94	40	54	200
SUB-TOTAL			740	

$$\text{* Where Density} = \frac{\text{Weight of waste}}{\text{Volume of container}}$$

Sheet 2 of 2

Incoming Solid Waste Density Determination

Field Data and Calculations

North Hempstead Incinerator
Roslyn Harbor

Date: 10-19-71

Time: 4:00 PM

TEST #1-B

Container No.	Weight of 55-gal container and waste	Container tare weight	Weight of waste	Density* of waste (lb/cu yd)
SUB-TOTAL BROUGHT FORWARD			740	
A-21	94	41	53	196
A-38	94	35	59	219
A-38	70	35	35	130
A-20	108	42	66	244
A-21	79	41	38	141
A-11	96	40	56	207
A-20	113	42	71	263
A-11	116	40	76	281
A-11	84	40	44	163
A-20	58 (**)	42	16	59 (**)
Average	96	(***) 39.5	56.3	208

Total 1254

* Where Density = $\frac{\text{Weight of waste}}{\text{Volume of container}}$

Comments:
1 Gal. = 231 Cu. In. = 0.1336 Cu. Ft.
55 Gal. = $\frac{55}{27}$ x 0.1336 = 0.27 C.Y. per barrel = 7.35 Cu/Ft.

(**) Disregarded
(***) Avg. of 21, 38, 20, 11

Incoming Solid Waste Composition Data

Laboratory Sample

North Hempstead Incinerator
Roslyn Harbor

Date: 10-19-71

Time____________

Sample No.____________

Component	Wet laboratory sample weight (lb)	Wet percentage*
Food Waste	0.4	2.5
Garden Waste	2.7	17.7
Paper Products 1. Newsprint	1.3	8.9
2. Corrugated boxboard	2.1	13.8
3. Other paper	5.6	37.3
Plastic	0.4	3.0
Rubber and Leather	0.2	1.2
Textiles	0.7	5.1
Wood	0.2	1.5
Fines	1.4	9.0
Combustibles Total	15.0	100.0
Metals 1. Ferrous	6.9	45.7
2. Non-ferrous	0.9	6.5
Glass	3.0	20.0
Ceramics	0.2	1.4
Ash, dirt, rocks	4.0	26.4
Noncombustibles Total	15.0	100.0
Total Sample		

$$* \text{ Wet percentage} = \frac{\text{individual wet laboratory sample weight}}{\text{total weight}} \times 100$$

REFUSE CHARGES INTO FURNACE

North Hempstead Incinerator
Roslyn Harbor

Date: 20 Oct. 1971

Shift 0000-0800

Furnace No. 1

TEST #1

BUCKET COUNT

0000-0100

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

0100-0200 0200-0300

23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42

0300-0400 0400-

43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62

0500 0500-0600

63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82

0600-0700 0700-0800

83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101

102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117

118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133

134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149

150 151 152 153 154 155 156 157 158 159 160

REFUSE CHARGES INTO FURNACE

North Hempstead Incinerator
Roslyn Harbor

Date: 20 Oct. 1971

Shift 0800 - 1600

Furnace No. 1

TEST #1

BUCKET COUNT

0800-0900

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

0900-1000

23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42

1000-1100

43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62

1100-1200 1200-1300

63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82

1300-1400

83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101

1400-1500

102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117

1500-1600

118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133

134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149

150 151 152 153 154 155 156 157 158 159 160

REFUSE CHARGES INTO FURNACE

North Hempstead Incinerator
Roslyn Harbor

Date: 20 Oct. 1971

Shift 1600-2400

Furnace No. 1

TEST #1

BUCKET COUNT

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42

43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62

63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82

83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101

102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117

118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133

134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149

150 151 152 153 154 155 156 157 158 159 160

COMMENTS:

Pit Empty at 12:10 P.M.

RESIDUE DISCHARGES FROM FURNACE

North Hempstead Incinerator
Roslyn Harbor

Date: 10/20/71

TEST #1

TIME	TRUCK	WEIGHT TRUCK & RESIDUE	TRUCK TARE WEIGHT	WEIGHT OF RESIDUE	ESTIMATED VOL. OF RESIDUE	TRUCK	BULK ++ DENSITY #/C.Y.
9:20	1	20,200	14,100	6,100	(*)	9.87 x	
10:40	2	23,720	"	9,620	80%	" x.80	1218
12:10	3	24,300	"	10,200	80%	" x.80	1292
1:05	4	21,480	"	7,380	60%	" x.60	1246
2:00	5	21,460	"	7,360	65%	" x.65	1147
2:55	6	21,760	"	7,660	60%	" x.60	1293
	7						
	8						
	9						
	10						
TOTAL				48,320			
AVERAGE							1239#/C.Y.

COMMENTS: (*) Not Observed

++ Wet Weight

Data Sheet 13
Sheet 1 of 2

RESIDUE FIELD SAMPLE SHIPPED

North Hempstead Incinerator
Roslyn Harbor

Date October 20, 1971

Test #1

DRUM NO.	TIME	WEIGHT OF CONTAINER AND RESIDUE (LB)	CONTAINER TARE WEIGHT (LB)	NET RESIDUE WEIGHT++ (LB)	DRUM NO.	TIME	WEIGHT OF CONTAINER AND RESIDUE (LB)	CONTAINER TARE WEIGHT (LB)	NET RESIDUE WEIGHT++ (LB)
1	9:50	213	20	193	18	12:34	226	18	208
2	:52	164	20	144	19	:35	219	18	201
3	:53	154	24	130	20	:37	213	18	195
4	:54	182	20	162	21	:40	292	20	272
5	:58	160	20	140	22	:41	282	18	264
6	10:00	184	20	164	23	:42	229	20	209
7	:02	190	20	170	24	:45	220	18	202
*8	:03	138	20	118	25	:55	272	18	254
9	:05	126	20	106			Sub-Total 'C'		1805
10	:15	202	22	180					
A-26	11:17	76	33	43	26	12:25	176	18	158
A-3	:17	77	41	36	27	:26	198	16	182
		Sub-Total 'A'		1586	28	:27	177	18	159
					29	:28	226	19	207
11	11:20	190	22	168	30	:29	308	17	291
12	:22	230	18	212	31	:30	231	20	211
13	:25	199	22	177	32	:35	246	22	224
14	:26	228	22	206	33	:44	259	24	235
15	:28	217	22	195			Sub-Total 'D'		1667
16	:30	222	20	202					
17	:50	203	18	185					
		Sub-Total 'B'		1345					

Sub-Total #1 ('A'+'B')	2931	Sub-Total #2 ('C'+'D')	3472
		Sub-Total #1	2931
		TOTAL Carried Forward	6403 lbs

*Transferred to Drum
No. 60

COMMENTS: ++ Wet Weight

NOTE: CONTAINER IS A 30 GALLON STEEL DRUM.
THE LID IS NOT TO BE INCLUDED IN ANY WEIGHTS.

Data Sheet 14
Sheet 2 of 2

RESIDUE FIELD SAMPLE SHIPPED

North Hempstead Incinerator
Roslyn Harbor

Date: October 20, 1971

Test #1

Total (1+2) brought forward 6403

DRUM NO.	TIME	WEIGHT OF CONTAINER AND RESIDUE (LB)	CONTAINER TARE WEIGHT (LB)	NET RESIDUE WEIGHT++ (LB)	DRUM NO.	TIME	WEIGHT OF CONTAINER AND RESIDUE (LB)	CONTAINER TARE WEIGHT (LB)	NET RESIDUE WEIGHT (LB)
A.38	2:10	72	35	37	)				
A.25	:11	88	50	38	)	BIG STUFF:	138#		
A.2	:12	94	31	63	)				
43	:17	162	20	142					
46	:18	184	24	160					
37	:20	180	21	159					
39	:21	253	23	230					
38	:22	262	22	240					
36	:24	250	20	230					
40	:25	206	21	185					
41	:26	251	20	231					
			Sub-Total 'E'	1715					
83	3:17	196	23	173					
59	:18	195	21	174					
64	:20	196	22	174					
55	:22	247	26	221					
84	:25	217	26	191					
48	:26	261	24	237					
69	:27	257	21	236					
76	:28	203	21	172					
A.4	:29	93	33	60	)				
.16	:30	74	34	40	)				
.50	:31	111	32	79	)	BIG STUFF:	239#		
.27	:32	100	40	60	)				
			Sub-Total #3	3542					

Grand Total: 1+2+3 = 9946 (lbs)

COMMENTS: ++ Wet Weight

TOTAL 9946 lbs

NOTE: CONTAINER IS A 30 GALLON STEEL DRUM.
THE LID IS NOT TO BE INCLUDED IN ANY WEIGHTS.

SIFTINGS & FLYASH FIELD SAMPLE TAKEN

North Hempstead Incinerator
Roslyn Harbor

Date: 10-20-71

TEST #1

TIME	PLACE TAKEN FROM		WEIGHT OF CONTAINER AND FLYASH (LBS)	TARE WEIGHT OF CONTAINER (LBS) (OZ.)	NET FLYASH WEIGHT (LBS)
12:46	Flyash Cyclone Collectors		55	-	55
12:48	Flyash Lagoon		69	-	69
11:22			423	34	389
TOTAL					

COMMENTS:

For field notes backup data see field notes "Residue Field Sample Shipped"

REFUSE DELIVERED TO PIT

North Hempstead Incinerator
Roslyn Harbor

Date: 3rd December 1971

Type of Waste:
Comm - Commercial
Res - Residential

Truck	Type of Waste	Time	Total Weight	Tare Weight	Net Weight: Lbs.
World Sani.	Comm.	7:10	41,220	25,100	16,120
Republic Cart.	Comm.	7:16	36,760	25,000	11,760
Grand Cart.	Comm.	7:19	33,680	27,400	6,280
L.I. Rubbish	Comm.	7:30	37,920	31,600	6,320
Reshard Cart.	Res.	7:43	21,720	18,100	3,620
North Atlantic	Comm.	7:47	46,260	38,200	8,080
J. Bauman	Res.	7:50	12,660	9,400	3,260
L.I. Rubbish	Comm.	7:52	43,580	36,000	7,580
Donno Co.	Res.	8:02	19,120	13,200	5,920
Donno Co.	Res.	8:04	18,080	13,400	4,680
Grand Cart.	Comm.	8:06	34,580	27,400	7,180
Donno Co.	Res.	8:18	26,240	19,200	7,040
Donno Co.	Res.	8:30	26,100	19,000	7,100
D. Allen	Res.	8:37	36,840	26,620	10,220
H. Anderson	Res.	8:43	15,580	13,000	2,580
Vill. Westbury	Res.	8:45	29,900	22,900	7,000
J. Bauman	Res.	8:47	13,860	9,600	4,260
Donno Co.	Res.	8:54	30,920	22,400	8,520

Sub Total: 127,520 lbs.

REFUSE DELIVERED TO PIT

North Hempstead Incinerator
Roslyn Harbor

Date: 3rd December 1971

Type of Waste:
Comm - Commercial
Res - Residential

Truck	Type of Waste	Time	Total Weight	Tare Weight	Net Weight: Lbs.
Donno Co.	Res.	8:58	31,180	22,400	8,780
Donno Co.	Res.	9:01	32,160	22,400	9,760
Donno Co.	Res.	9:04	27,820	22,400	5,420
Vill. Westbury	Res.	9:07	28,720	22,900	5,820
D. Allen	Res.	9:10	23,620	18,400	5,220
Donno Co.	Res.	9:12	39,440	27,200	12,240
Vill. Westbury	Res.	9:14	36,240	22,700	13,540
Star Cart.	Comm.	9:16	36,800	29,100	7,700
Donno Co.	Res.	9:18	16,000	13,000	3,000
Vill. Westbury	Res.	9:20	26,900	19,300	7,600
J. Bauman	Res.	9:25	12,800	9,600	3,400
Donno Co.	Res.	9:27	19,400	13,400	6,000
Donno Co.	Res.	9:42	18,000	13,400	4,600

Sub Total 90,080 lbs.

Grand Sub Total 220,600 lbs.
or
110.3 Tons

REFUSE DELIVERED TO PIT

North Hempstead Incinerator
Roslyn Harbor

Date: 4th December 1971

Type of Waste:
Comm - Commercial
Res - Residential

Truck	Type of Waste	Time	Total Weight	Tare Weight	Net Weight: Lbs.
World Sani.	Comm.	7:04 am	41,360	25,100	16,260
Donno Co.	Res.	7:11	24,180	19,000	5,180
L.I. Rubbish	Comm.	7:19	41,960	31,600	10,360
Donno Co.	Res.	7:21	17,840	13,900	3,940
Donno Co.	Res.	7:27	25,520	20,600	4,920
Southside Ct.	Comm.	7:39	27,760	24,000	3,760
Donno Co.	Res.	7:42	32,020	22,400	9,620
J. Bauman	Res.	7:44	11,460	9,400	2,060
Southside	Comm.	7:51	36,820	28,100	8,720
Southside	Comm.	7:54	32,880	28,000	4,880
Vill. New Hyde Pk.	Res.	8:04	29,440	18,900	10,540
Greenbay	Comm.	8:09	45,420	27,100	18,320
Star Cart.	Comm.	8:11	36,940	29,100	7,840
Jamaica Ash	Comm.	8:13	33,960	27,700	6,260
Donno Co.	Res.	8:14	16,780	13,000	3,780
Donno Co.	Res.	8:16	19,560	13,200	6,360
Donno Co.	Res.	8:26	27,680	19,200	8,480
Donno Co.	Res.	8:34	18,420	14,000	4,420
				Sub Total	135,700 lbs.

REFUSE DELIVERED TO PIT

North Hempstead Incinerator
Roslyn Harbor

Date: 4th December 1971

Type of Waste:
Comm - Commercial
Res - Residential

Truck	Type of Waste	Time	Total Weight	Tare Weight	Net Weight: Lbs.
Vill. New Hyde Pk.	Res.	8:38	22,020	17,960	4,060
Vill. New Hyde Pk.	Res.	8:40	27,760	18,300	9,460
Southside Ct.	Comm.	8:42	36,220	28,140	8,080
Donno Co.	Res.	8:43	29,460	22,400	7,060
Donno Co.	Res.	8:46	31,680	22,260	9,420
H. Anderson	Res.	8:47	28,820	22,400	6,420
Donno Co	Res.	8:50	30,220	22,400	7,820
Donno Co.	Res.	8:55	17,960	13,900	4,060
V & J Rubbish	Comm.	8:57	37,820	30,000	7,820
Reshard Cart.	Res.	8:58	24,220	18,100	6,120
Donno Co.	Res.	8:59	45,740	27,200	18,540

Sub Total	88,860 lbs.
Grand Sub Total	224,560 lbs.
Grand Total	445,160 lbs. or 222.5 Tons

REFUSE CHARGES INTO FURNACE

North Hempstead Incinerator
Roslyn Harbor

Date: Dec. 6, 1971

Shift 1600-2400

Furnace No. 3

TEST #2

BUCKET COUNT

~~1~~ ~~2~~ ~~3~~ ~~4~~ ~~5~~ ~~6~~ ~~7~~ ~~8~~ ~~9~~ ~~10~~ ~~11~~ ~~12~~ ~~13~~ ~~14~~ ~~15~~ ~~16~~ ~~17~~ ~~18~~ ~~19~~ ~~20~~ ~~21~~ ~~22~~

~~23~~ ~~24~~ ~~25~~ ~~26~~ ~~27~~ ~~28~~ ~~29~~ ~~30~~ ~~31~~ ~~32~~ ~~33~~ ~~34~~ ~~35~~ ~~36~~ ~~37~~ ~~38~~ ~~39~~ ~~40~~ ~~41~~ ~~42~~

~~43~~ ~~44~~ ~~45~~ ~~46~~ ~~47~~ ~~48~~ ~~49~~ ~~50~~ ~~51~~ ~~52~~ ~~53~~ ~~54~~ ~~55~~ ~~56~~ ~~57~~ ~~58~~ ~~59~~ ~~60~~ ~~61~~ ~~62~~

~~63~~ ~~64~~ ~~65~~ ~~66~~ ~~67~~ ~~68~~ ~~69~~ ~~70~~ ~~71~~ ~~72~~ ~~73~~ ~~74~~ ~~75~~ ~~76~~ ~~77~~ ~~78~~ ~~79~~ ~~80~~ ~~81~~ ~~82~~

~~83~~ ~~84~~ ~~85~~ ~~86~~ ~~87~~ ~~88~~ ~~89~~ ~~90~~ ~~91~~ ~~92~~ ~~93~~ ~~94~~ ~~95~~ ~~96~~ ~~97~~ ~~98~~ ~~99~~ ~~100~~ ~~101~~

~~102~~ ~~103~~ ~~104~~ ~~105~~ ~~106~~ ~~107~~ ~~108~~ ~~109~~ ~~110~~ ~~111~~ ~~112~~ ~~113~~ ~~114~~ ~~115~~ ~~116~~ ~~117~~

12:30 AM

~~118~~ ~~119~~ ~~120~~ ~~121~~ ~~122~~ ~~123~~ ~~124~~ ~~125~~ ~~126~~ ~~127~~ ~~128~~ ~~129~~ 130 131 132 133

134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149

150 151 152 153 154 155 156 157 158 159 160

COMMENTS:

Pit Empty at 12:30 AM

Sheet 1 of 1

RESIDUE FIELD SAMPLE SHIPPED

North Hempstead Incinerator
Roslyn Harbor

Date: 12-6-71

Test #2

DRUM NO.	TIME SAMPLE TAKEN	WEIGHT OF CONTAINER AND RESIDUE (LB)	CONTAINER TARE WEIGHT (LB)	NET RESIDUE WEIGHT (LB)	DRUM NO.	TIME SAMPLE TAKEN	WEIGHT OF CONTAINER AND RESIDUE (LB)	CONTAINER TARE WEIGHT (LB)	NET RESIDUE WEIGHT (LB)
93	10:00 to 10:20	215	22	193	80	3:20 to 3:40	191	26	165
68		123	21	102	50		216	23	193
70		197	21	176	57		125	22	103
52		114	22	92	66		179	22	157
47		125	24	101	79	4:40 to 4:45	140	21	119
49	11:20 to 11:40	149	21	128	85		114	20	94
90		188	27	161	91		178	22	156
44		75	21	54	45		113	20	93
08		117	20	97	67		257	28	229
53		161	20	141	88	5:05 to 5:10	167	21	146
95		162	22	140	58		186	21	165
34		150	22	128					
101	1:30 to 1:45	233	22	211	A33		193	41	*152
86		178	22	156					* 75
72		168	21	147					* 66
97		109	23	86					* 34.5
89	2:25 to 2:45	211	23	188					
61		179	20	159					
56		164	23	141					

NOTE: Container is 30-Gallon Steel Drum, except A-33 is 55-Gallon Steel Drum. The lid is not included in any weights.

TOTAL 4552.5 lbs = 2.27 Tons

* Massive items that were too large to be processed in the Bureau of Mines system were not placed in containers to be shipped, but were placed aside until the residue sampling was completed. Upon completion these items were weighed separately.

A total of 327-1/2 lbs of massive metal and organics were withheld.

These massive items included:

- Sheet Metal
- Large 55 Gallon Drums
- A tail pipe from an automobile
- Bicycle frame
- Various automobile parts
- Aluminum chair frame (8 lbs)
- Metal drum covers of different sizes
- Rug (unburned carpet) (34.5 lbs)
- Concrete blocks (46 lbs)
- Metal cans and containers of assorted sizes
- Metal window fan

WEIGHT REDUCTION - TEST #1

Refuse:

Refuse input - 201.2 tons = 402,000#
Combustible fraction = 80% @ 18% moisture
Non-combustible fraction = 20% @ 6.4% moisture

Dry refuse input =
.8 x 402,400 = 322,000# x .82 = 264,000
.2 x 402,400 = 80,400# x .936 = 75,000
339,000#

Residue:

Residue shipped to BOM = 9,946# wet Residue weighed by BOM = 9,716# wet	2.4% moisture loss during transit

Moisture of sample (from BOM) = 37.8%
Total moisture = 37.8 + 2.4 = 40.2

48,320# collected during 7 hours = 6,900 #/hr
6,900 x 24 = 165,800# wet
165,800 x .598 = 99,100# dry residue/day

$$\text{Weight reduction} = \frac{339{,}000 - 99{,}100}{339{,}000} \times 100 = 70.8\%$$

WEIGHT REDUCTION - TEST #2

Refuse:

Refuse Input = 222.72 tons = 445,430 lbs.

Combustible Fraction = 80% @ 18% moisture.

Non-combustible Fraction = 20% @ 6.4 moisture.

Dry refuse input =

.8 x 445,430# = 356,344# x .82 = 292,202.0#
.2 x 445,430# = 89,086# x .936 = 83,384.5#

375,586.5#

Residue:

Wet residue shipped to BOM = 4,552.5 lbs.
Wet residue weighed by BOM = 4,493.5 lbs.
Moisture loss during shipment = 1.3%
Dry residue weighed by BOM = 3,650.5 lbs.
Moisture content of BOM sample = 18.8%
Total moisture content (18.8 + 1.3) = 20.1%

4,552.5 lbs (wet) collected in 105 min. = 43.35 lbs/min.
1,440 min/day x 43.35 lbs/min. = 62,420 lbs/day (wet)

62,420 lbs/day x .799 = 49,874 dry residue/day

$$\% \text{ weight reduction} = \frac{375,800 - 49,874}{375,800} \times 100 = 86.7\%$$

VOLUME REDUCTION

TEST NO. 1

Weight of wet refuse produced per day = 402,350 lbs

Average density = 190.5 lbs/cy

Number of cubic yards input =

$$\frac{402{,}350 \text{ lbs}}{190.5 \text{ lbs/cy}} = 2{,}112 \text{ cubic yards}$$

Weight of wet residue produced per day = 165,800 lbs

Density of residue = 1,238 lbs/cu yd

Number of cubic yards output =

$$\frac{165{,}800 \text{ lbs}}{1{,}238 \text{ lbs/cy}} = 133.9 \text{ cu yd (wet)}$$

Volume reduction =

$$\frac{2{,}112 \text{ cy} - 133.9 \text{ cy}}{2{,}112 \text{ cy}} \times 100 = 93.6\%$$

VOLUME REDUCTION

TEST NO. 2

Average density of refuse test No. 2 = 429#/cy

Number of cubic yards input:

$$\frac{445{,}430 \text{ lbs}}{429 \text{ lbs/cy}} = 1{,}038.3 \text{ cy}$$

Density of residue = 950.6 lbs/cy or Al't. 1,000 lb/cy

Number of cubic yards output:

$$\frac{62{,}420 \text{ lbs}}{950.6 \text{ lbs/cy}} = 65.6 \text{ cy (wet)} \qquad \frac{49{,}874}{950.6} = 52.5 \text{ (dry)}$$

Volume reduction =

$$\frac{1{,}038.3 \text{ cy} - 65.6 \text{ cy}}{1{,}038.3 \text{ cy}} \times 100 = \frac{972.7 \text{ cy}}{1{,}038.3 \text{ cy}} \times 100 = 93.6\%$$

VOLUME OF RESIDUE - TEST NO. 1

Total weight of residue collected in drums = 9,441 lbs

Avg. weight per drum = 9,441 lb ÷ 49 drums = 192.6 lbs

1 gal = 231 cu in = 0.1336 cu ft
30 gal = 4 cu ft

Average density = $\frac{192.6 \text{ lbs}}{4 \text{ cu ft}}$ = 48.15 lbs/cu ft

48.15 lbs/cu ft x 27 cu ft/cu yd = 1,300 lbs/cu yd

VOLUME OF RESIDUE - TEST NO. 2

RESIDUE TEST NO. 2

Total weight of residue collected in drums = 4,225 lbs

Avg. weight per drum = 4,225 ÷ 30 drums = 140.8 lbs

1 gal = 231 cu in. = 0.1336 cu ft
30 gal = 4.0 cu ft

$$\text{Average density} = \frac{140.8 \text{ lbs}}{4.0 \text{ cf}} = 35.2 \text{ lbs/cu ft}$$

35.2 lbs/cu ft x 27 cu ft/cu yd = 950.6 lbs/cy

New York Testing Laboratories Report

NEW YORK TESTING LABORATORIES, INC.
81 URBAN AVENUE, WESTBURY, L. I., N.Y. 11590 • 516 EDgewood 4-7770

Lab. No. K-39,933

Page 1.

October 28, 1971

CLIENT:	Leonard S. Wegman Company 101 Park Avenue New York, N. Y. 10017 Attention: Mr. R. Cummings
MATERIAL:	Solid Waste Sample
YOUR ORDER NO.:	Pending
SUBMITTED FOR:	Chemical Analysis Utilizing EPA Procedures outlined in the Incinerator Evaluation Manual developed by the Solid Waste Management Program.

RESULTS

See following pages.

Incoming Solid Waste Moisture Determination

Lab. No. K-39,933

Page 2.

Laboratory Data and Calculations

Plant ______________________ Date __________

Sample No. __________________ Time __________

Organization ________________ Performed by __________

Component	Weight of pan (lb)		Wet laboratory sample weight plus pan (lb)		Dry laboratory sample weight plus pan (lb)	
Combustibles	W_{wmk}	3.16	W_{wmb}	17.74	W_{wmj}	15.12
Noncombustibles	W_{wmx}	5.75	W_{wmo}	20.12	W_{wmq}	19.20

From Incoming Solid Waste Composition Data, Field Sample

Wet percentage of combustibles components W_{pcw} = 50.36

Wet percentage of noncombustibles components W_{pnw} = 49.64

Moisture content of combustibles sample, percent W_{pmc} = 17.96

$$W_{pmc} = \left(\frac{W_{wmb}-W_{wmj}}{W_{wmb}-W_{wmk}}\right) 100$$

Moisture content of noncombustibles sample, percent W_{pmn} = 1.49

$$W_{pmn} = \left(\frac{W_{wmo}-W_{wmq}}{W_{wmo}-W_{wmx}}\right) 100$$

Moisture content of total field sample, percent W_{pmt} = 9.78

$$W_{pmt} = \frac{(W_{pmc})(W_{pcw}) + (W_{pmn})(W_{pnw})}{100}$$

Comments:

Dry Combustibles and Noncombustibles Percentages

Page 3. **Calculations** Lab. No. K-39,933

From Incoming Solid Waste Composition Data, Field Sample

Wet weight of combustibles field sample, lb W_{wcw} = 14.58

Wet weight of noncombustibles field sample, lb W_{wnw} = 14.37

Wet weight of total field sample, lb W_{wtw} = 28.95

From Incoming Solid Waste Moisture Determination, Laboratory Data and Calculations

Moisture content of combustibles sample, percent W_{pmc} = 17.96

Moisture content of noncombustibles sample, percent W_{pmn} = 1.49

Moisture content of total field sample, percent W_{pmt} = 9.78

Dry combustibles percentage of field sample W_{pcd} = 45.82

$$W_{pcd} = \left[\frac{W_{wcw} - \left(\frac{W_{pmc}}{100}\right)\left(W_{wcw}\right)}{W_{wtw} - \left(\frac{W_{pmt}}{100}\right)\left(W_{wtw}\right)}\right] 100$$

Dry noncombustibles percentage of field sample W_{pnd} = 54.18

$$W_{pnd} = \left[\frac{W_{wnw} - \left(\frac{W_{pmn}}{100}\right)\left(W_{wnw}\right)}{W_{wtw} - \left(\frac{W_{pmt}}{100}\right)\left(W_{wtw}\right)}\right] 100$$

Comments:

Incoming Solid Waste Volatile and Ash Determinations

Page 4.

Laboratory Data and Calculations

Lab. No. K-39,933

Plant ______________________ Date __________

Sample No. ________________ Time __________

Organization ____________ Performed by ____________

W_{wvb} Weight of crucible (mg)	W_{wvj} Weight of volatile sample and crucible (mg)	W_{wvk} Weight of volatile sample and crucible after muffling (mg)
23326.4	27657.4	23529.4

From Dry Combustibles and Noncombustibles Percentages. Calculations

Dry combustibles percentage of field sample W_{pcd} = 45.82

Volatile content of prepared sample, percent W_{pvp} = 95.28

$$W_{pvp} = \left(\frac{W_{wvj}-W_{wvk}}{W_{wvj}-W_{wvb}}\right)100$$

Volatile content of total dry field sample, percent W_{pvt} = 43.65

$$W_{pvt} = \frac{(W_{pvp})(W_{pcd})}{100}$$

Ash content of total dry field sample, percent W_{pat} = 56.35

$$W_{pat} = 100.0 - W_{pvt}$$

Comments:

Incoming Solid Waste Heat Content Determination

Calculations

Lab. No. K-39,933

Plant ________________ Date ________________

Sample No. ________________ Time ________________

Organization ________________ Performed by ________________

From Incoming Solid Waste Moisture Determination, Laboratory Data and Calculations

Moisture content of total field sample, percent W_{pmt} = 9.78

From Dry Combustibles and Noncombustibles Percentages, Calculations

Dry noncombustibles percentage of field sample W_{pnd} = 54.18

From Parr Adiabatic Calorimeter Calculations

Heat content of the prepared sample, Btu/lb W_{hcp} = 7,054

Heattcontent of total field sample "as received", Btu/lb W_{htf} = 2,468

$$W_{htf} = W_{hcp} \left[1 - \left(\frac{W_{pmt} + W_{pnd}}{100} \right) \right]$$

Comments:

Incoming Solid Waste Ultimate Analysis

Page 6. **Laboratory Data and Calculations** Lab. No. K-39,933

Plant ______________________ **Date** ______________

Sample No. ______________________ **Time** ______________

Organization ______________________ **Performed by** ______________

From laboratory analyses:

Constituent	Percentage of dry combustibles prepared sample		
Carbon	W_{pgp}	39.94	
Hydrogen	W_{php}	5.82	
Sulfur	W_{psp}	0.17	
Chlorine	W_{pkp}	0.35	
Oxygen	W_{pop}	48.85	
Nitrogen	W_{pnp}	0.12	
Ash	W_{pap}	4.72	
Total	----	99.97	100

From Incoming Solid Waste Composition Data, Field Sample

Wet weight of combustibles field sample, lb W_{wcw} = _____

Wet weight of noncombustibles field sample, lb W_{wnw} = _____

Wet weight of total field sample W_{wtw} = _____

From Incoming Solid Waste Moisture Determination, Laboratory Data and Calculations

Moisture content of combustibles sample, percent W_{pmc} = 17.96

Moisture content of noncombustibles sample, percent W_{pmn} = 1.49

Moisture content of total field sample, percent W_{pmt} = 9.78

C E R T I F I C A T I O N

We certify that this report is a true report of results obtained from tests of this material.

Respectfully submitted,

NEW YORK TESTING LABORATORIES, INC.

G. J. Horvitz
Chief Officer

gt

APPENDIX C.3

U.S. Bureau of Mines Analysis

United States Department of the Interior
BUREAU OF MINES
COLLEGE PARK, MARYLAND 20740

December 21, 1971

Memorandum

To : Martin H. Stanczyk, Supervisory Metallurgist
College Park Metallurgy Research Center

From : Physical Science Technician, College Park
Metallurgy Research Center

Subject: Processing of Residues From Roslyn Incinerator,
Roslyn, New York (SW-144)

Fifty-nine drums of incinerator residues were received from the Roslyn, New York incinerator. The sample was composed of forty-nine 30 gallon drums of residue with the massive materials removed. Nine- 55 gallon drums contained the massive materials which were separated when the sample was collected, one 55 gallon drum contained grate, siftings which were smaller than 2 inches in size. The sample was processed in the pilot plant on October 21 and 22, 1971. The objective was to evaluate the continuous system for processing residues from this incinerator.

The sample was randomly split into two parts in an effort to even the feed to the system over the two-day run. The two sets of numbers in the order in which the barrels were fed to the reclamation plant are given in Table 1.

Table 1. - Numerical Order in which drums were processed.

Drum number October 21, 1971		Drum number October 22, 1971	
3	69	2	22
13	5	27	39
41	55	28	21
33	7	37	19
24	60	20	12
83	84	43	11
15	9	36	30
4	59	38	1
16	76	29	40
14	64	31	32
10	6	46	18
48	17	26	23
25			

Test Results:

Each drum was weighed as received and samples taken to determine the moisture content. The average moisture of the total sample was 37.8 percent H_2O. This was in part, due to the high percentage of paper and grass. The total weight of the sample was 9,716 pounds and the dry weight was 6,043 pounds. The average wet weight per drum of residue was 187.5 pounds. The residue was fed to the system at a feed rate of five drums or approximately 937.5 pounds (wet weight) per hour. One 55 gallon drum of material (grate siftings) was processed separately. Material balances for the residue sample and grate siftings are given in Table 2.

During processing, massive iron, unburned paper and large gobs of grass were removed both at the feed apron and the picking station. The unburned paper and grass was removed to prevent blinding of the screens. The data given in Table 2 show that the residue contained an average 14.7 percent of unburned paper, grass and organic matter. During processing, most of the grass and organic matter reported in the coarse nonferrous metal product. Before cleaning the coarse nonferrous metal product, about 70.0 percent of the product was organic matter. To clean this product, it was necessary to dry and elutriate the material. Samples of both the coarse and fine nonferrous metals were then smelted and analyzed to determine the major metals present. The data given in Table 3 show aluminum, copper, zinc and lead as the major metals in these products. To reclaim an aluminum product, a 26-pound sample of the cleaned coarse nonferrous metal composite was processed using a laboratory heavy media procedure. The sink-float test revealed that 67.3 percent of the material floated in a 2.97 SG media, and 27.9 percent had a gravity heavier than 2.97. Approximately 4.8 percent of the cleaned product was fine organic matter.

An unusually high percentage (9.5 percent) of massive iron also was found. The massive product included auto water-pumps, brake drums, bed springs, auto wheels, electric motors, bicycle and tricycle frames and large sheets of metal. The total iron content amounted to 23.8 percent of the sample. Samples of the coarse and fine magnetic materials, were smelted and analyzed for residual impurities. An analysis of the smelted samples is given in Table 4. The data show that tin was the major contaminant. The copper and silicon content of the iron product were within specifications for steel making scrap.

The data given in Table 2 show that the total glass content of the sample was somewhat low. Microscopic examination of the glass reclaimed from the residue revealed that little or no slagging

Table 2. - Materials Balance
(Roslyn, New York)

Products	Sample 144		Sample 144A	
	Dry weight, Pounds	Weight, Percent	Dry weight, Pounds	Weight, Percent
Massive iron	576.4	9.5	--	--
Permanent drum magnetics	675.1	11.2	23.0	7.1
Electro-drum magnetics	185.5	3.1	22.0	6.9
Coarse nonferrous metals	54.6	.9	17.5	5.5
Fine nonferrous metals	76.9	1.3	6.5	2.0
Nonmagnetic glass	1122.5	18.6	97.0	30.2
Magnetic glass	636.4	10.5	75.0	23.4
Classifier sands	807.4	13.3	78.5	24.5
Filter cake	1020.9	16.9	--	--
Unburned paper	592.0	9.8	--	--
Grass, plus organics	295.0	4.9	1.5	.4
TOTAL	6042,7	100.0	321.0	100.0

Table 3. - Chemical Analysis of Coarse and Fine
Nonferrous Metals (Roslyn, New York)

Sample	Analysis, Percent					
	Al	Cu	Mg	Zn	Mn	Pb
SW - 144 Coarse	58.9	17.7	.11	13.8	.28	3.65
SW - 144 Fine	62.8	6.3	.10	11.3	.28	1.14

Table 4. - Chemical Analysis of Coarse and Fine
Ferrous Metals (Roslyn, New York)

Sample	Analysis, Percent						
	Fe	Cu	Sn	Pb	Si	C	S
SW - 144 Coarse	98.0	.47	.23	.01	.10	2.17	0.03
SW - 144 Fine	99.0	.57	.18	.01	.09	0.98	0.08

Table 5. - Sizing Analysis of Glass Products (Roslyn, New York)

Screen size	Colorless nonmagnetic weight	percent	Colored magnetic weight	percent	Composite of Colored & Colorless weight	percent
Plus 35 mesh	4.3	100.0[1]	8.9	100.0	6.6	100.0[1]
Minus 35, plus 60 mesh	26.1	95.7	31.2	91.1	28.7	93.4
Minus 60, plus 100 mesh	31.1	69.6	28.9	59.9	30.0	64.7
Minus 100, plus 150 mesh	15.0	38.5	12.0	31.0	13.5	34.7
Minus 150, plus 200 mesh	9.0	23.5	7.9	19.0	8.5	21.2
Minus 200, plus 270 mesh	8.3	14.5	5.8	11.1	7.0	12.7
Minus 270 mesh	6.2	6.2	5.3	5.3	5.7	5.7

[1] Indicates percentage of glass finer than largest mesh size shown on that line.

Table 6. - Petrographic Analysis of Classifier Sands and Filter Cake.

Classifier Sands	Approximate analysis, percent
Clear glass	4.5
Colored glass	15
Red and black opaque material	15
Calcite	5
Black scoria (slag)	10
Magnetics	10
Quartz	10
Carbon[1]	1.1
Filter Cake	Approximate analysis, percent
Fine glass (all colors)	50-70 percent
Red and black opaque material	15
Calcite	10
Quartz	3-5 percent
Carbon[1]	1.7

[1] Determined by quantitative chemical analysis.

took place during incineration. The nonmagnetic colorless glass concentrate appeared to be very clean, but extremely fine in size. Owing to the relatively low quantity of glass that was fed to the rod mill, a great deal of overgrinding occurred. Sizing analyses of the colorless and colored glass products, which are given in Table 5, indicate that over 34 percent of the glass fed to the high intensity magnetic separators was finer than 100-mesh in size.

Except for minor problems in the slime flocculation and filtration circuit, the residue responded to the beneficiation process without any processing changes. The slime content of the sample was unusually high (16.9 percent) and extremely difficult to flocculate and settle. Filtration of the settled slime also was extremely difficult. The problem in settling and filtering the large amount of slime was aggravated by the fact that the product contained a high percentage of unburned cellulose and grass fibers. However, during this run the problem was partially solved by additions of ferrous sulfate and soda ash to our standard flocculating agent (Hercofloc 822).

Samples of both the classifier sands and filter cake were submitted for petrographic and x-ray analysis. The results are given in Table 6. The data show that both products contained appreciable quantities of glass and a very small amount of carbon. Additional research is planned to determine the feasibility of reclaiming additional glass from these products by a froth flotation scheme.

Kenneth H. Ivey
Ken Ivey

United States Department of the Interior
BUREAU OF MINES
COLLEGE PARK, MARYLAND 20740

February 28, 1972

Memorandum

To : Martin H. Stanczyk, Supervisory Metallurgist,
College Park Metallurgy Research Center

From : Physical Science Technician, College Park
Metallurgy Research Center

Subject: Processing of Residues From Roslyn Incinerator
Roslyn, New York (SW-148)

Another sample of incinerator residue was received from the Roslyn Incinerator and processed through the continuous pilot plant on December 7, 1971. This second sample was comprised of thirty 30 gallon drums of material. The objective of this second test was to process residues from this incinerator after a more thorough burnout than that observed in the first sample that was processed on October 21-22, 1971.

Test Results:

Each drum was weighed as received and samples taken to determine the moisture content. The average moisture of the total sample was 19.4 percent H_2O. The total weight of the sample was 4,326 pounds and the dry weight was 3,486 pounds. The average wet weight per drum was 144 pounds.

During the processing, massive iron and large pieces of paper were removed at the feeding apron and the picking station. The data given in table 1 show that the residue contained only 1.4 percent of unburned paper and organic matter. The first sample contained 14.7 percent unburned paper and organics.

During processing, most of the organic matter reported in the coarse nonferrous metal product. To remove all the organic matter from the nonferrous metals, the product was dried and subsequently elutriated. As shown in table 1 the nonferrous metals content was unexpectedly low being only 1.0 percent. The first Roslyn sample contained a total of 2.2 percent nonferrous metals.

The total iron content of the sample amounted to 32.7 percent. About 10.4 percent of the residue was massive iron. The massive iron product included 55 gallon drums, parts of bicycles, heavy metal lids, auto tail pipes and other auto parts.

The data given in table 1 also show that the total glass content of the sample was 36.6 percent. Microscopic examination of the glass reclaimed from the residue revealed little or no slagging took place during incineration. The nonmagnetic colorless glass concentrate appeared to be very clean. Sizing analysis of the colorless and colored glass products, which are given in table 2, indicate that 44 percent of the glass feed to the high intensity magnetic separators was finer than 100 mesh in size.

No problems were encountered in the slimes flocculation and filtration circuit, in fact, the total residue sample responded to the beneficiation process much better than the first sample of residue from the Roslyn Incinerator.

Samples of both the classifier sands and filter cake were submitted for petrographic and X-ray analysis. The results are given in table 3. The data show that both products contain appreciable quantities of glass and a small amount of carbon. Additional research is underway to determine the quality of glass recovered from the classifier sands.

Samples of both the coarse and fine nonferrous metals were smelted and analyzed to determine the major metals present. The data given in table 4 show aluminum, copper, zinc, lead and iron as the major metals in these products. The high iron content is apparently due to stainless steel that could not be removed by the magnetic separators.

To reclaim an aluminum product, the remainder of the coarse and fine nonferrous metal products were processed using a laboratory heavy liquid separation procedure. The heavy liquid had a specific gravity of 2.97.

The sink-float test revealed that 51.2 percent of the coarse material floated and 48.8 percent of the material had a gravity heavier than 2.97. The fine nonferrous metals yield was 73.8 percent as a float product, and 26.2 percent as a sink material.

Samples of the coarse and fine magnetic materials were smelted and analyzed for residual impurities. An analysis of the smelted samples is given in table 5. The data show that copper and tin are the major contaminants and may be too high to meet the specifications for scrap steel production.

Signed

Kenneth Ivey

Table 1 - Materials Balance SW-148
(Roslyn, New York)

Products	Sample No. 148 Dry Weight, Pounds	Weight, Percent
Massive iron[1]	362.5	10.4
Permanent drum magnetics	602.0	17.3
Electro-drum magnetics	174.1	5.0
Coarse nonferrous metals[2]	17.2	0.5
Fine nonferrous metals	16.4	0.5
Nonmagnetic glass[3]	692.5	19.8
Magnetic glass	587.0	16.8
Classifier sands[3]	594.7	17.1
Filter cake	394.6	11.3
Unburned paper, plus organics[4]	45.0	1.3
Total	3,486.0	100.0

---

[1] Material withheld at incinerator, weight of material 160 pounds.

[2] Includes aluminum chair frame withheld at incinerator estimated weight 3.0 pounds.

[3] Concrete blocks and cement sign post holder withheld at incinerator were not included in materials balance but would normally report in these two fractions.

[4] Not included in materials balance a 34.5 pound rug withheld at incinerator.

Table 2 - Sizing Analysis of Glass Products (SW-148)

Screen Size	Colorless Nonmagnetic		Colored Magnetic		Composite colorless + colored	
	Weight	Percent	Weight	Percent	Weight	Percent
Minus 20, plus 35 mesh	9.7	100.0[1]	13.2	100.0	11.5	100.0
Minus 35, plus 60 mesh	18.8	90.3	22.4	86.8	20.6	88.5
Minus 60, plus 100 mesh	27.0	71.5	26.6	64.4	26.8	67.9
Minus 100, plus 150 mesh	16.7	44.5	14.8	37.8	15.7	41.1
Minus 150, plus 200 mesh	11.6	27.8	8.4	23.0	10.0	25.4
Minus 200, plus 270 mesh	8.2	16.2	6.0	14.6	7.1	15.4
Minus 270 mesh	8.0	8.0	8.6	8.6	8.3	8.3

---

[1] Indicates percentage of glass finer than largest mesh size shown on that line.

Table 3 - Petrographic Analysis of Classifier Sands and Filter Cake (SW-148)

Classifier Sands	Approximate analysis, percent
Clear glass	50
Colored glass	10
Magnetics (scale)	15
White opaque (quartz)	10
Black slag - nonmagnetic	5
Red and brown slag	10
Carbon [1]	.59
Filter Cake	
White fused opaque (quartz)	10
Fibers	15
glass	12
magnetic (scale)	10
Fines, dirty	remainder
Carbon [1]	7.6

---

[1] Determined by quantitative chemical analysis.

Table 4 - Chemical Analysis of Coarse and Fine Nonferrous Metals (SW-148)

	Analysis, Percent							
Sample	Al	Cu	Mg	Zn	Mn	Pb	Fe	Si
SW-148, Coarse	41.6	36.4	.05	14.2	.24	.76	3.45	.41
SW-148, Fine	65.4	14.0	.02	7.9	.47	1.74	3.00	.67

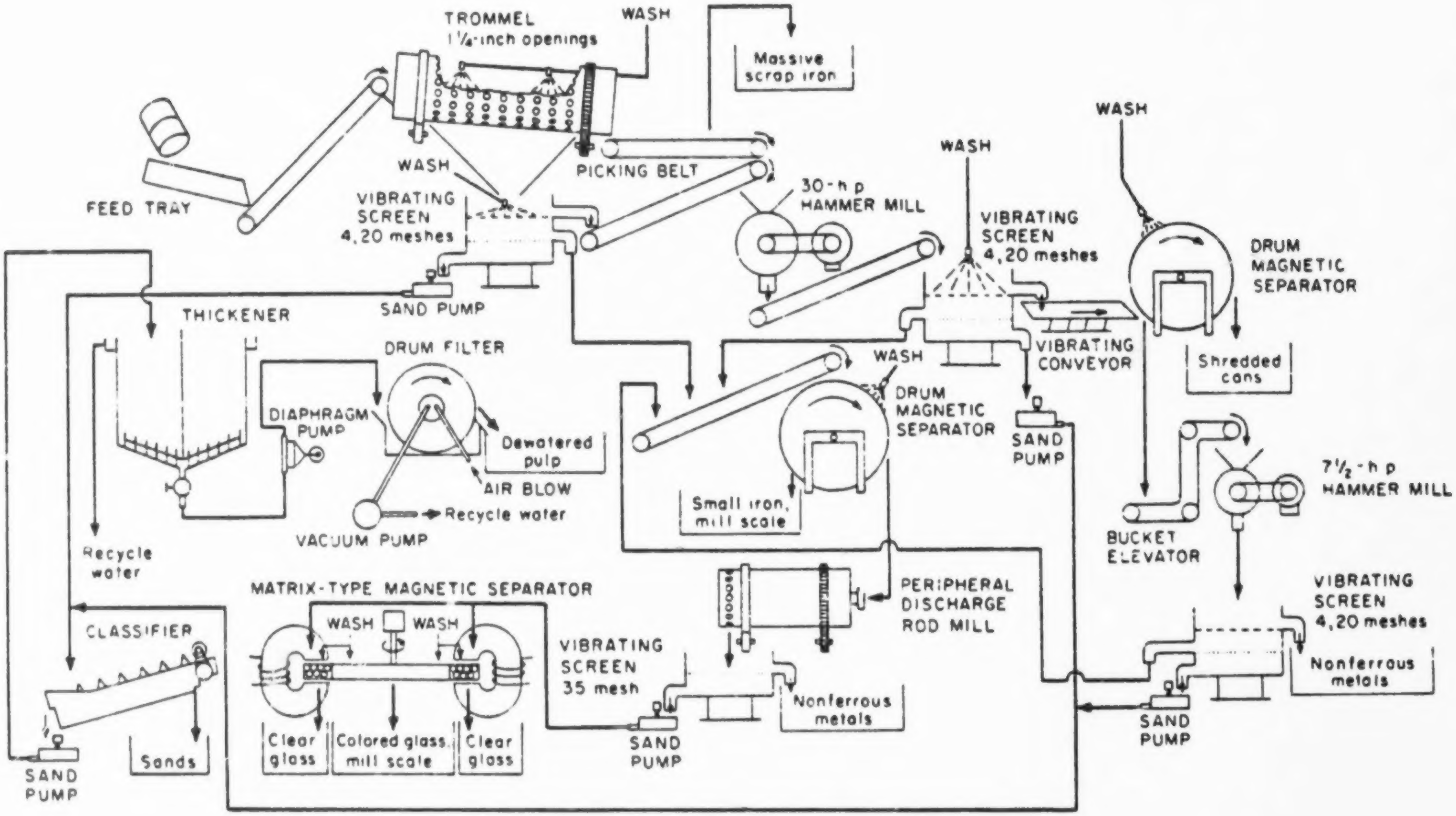
Table 5 - Chemical Analysis of Coarse and Fine Ferrous Metals. (SW-148)

	Analysis, Percent						
Sample	Fe	Cu	Sn	Pb	Si	C	S
SW-148, Coarse	96.0	.05	.30	ND	.06	2.25	.01
SW-148, Fine	95.0	.69	.13	ND	.57	.63	.04

APPENDIX C.4

FLOW DIAGRAM

UNITED STATES BUREAU OF MINES PILOT PLANT
COLLEGE PARK, MARYLAND


TROMMEL
1¼-inch openings
WASH
Massive scrap iron
WASH
FEED TRAY
WASH
PICKING BELT
VIBRATING SCREEN 4,20 meshes
30-h p HAMMER MILL
WASH
VIBRATING SCREEN 4,20 meshes
DRUM MAGNETIC SEPARATOR
SAND PUMP
THICKENER
DRUM FILTER
VIBRATING CONVEYOR
Shredded cans
WASH
DIAPHRAGM PUMP
Dewatered pulp
DRUM MAGNETIC SEPARATOR
SAND PUMP
AIR BLOW
7½-h p HAMMER MILL
Recycle water
Small iron, mill scale
VACUUM PUMP
BUCKET ELEVATOR
Recycle water
MATRIX-TYPE MAGNETIC SEPARATOR
PERIPHERAL DISCHARGE ROD MILL
VIBRATING SCREEN 4,20 meshes
WASH
WASH
CLASSIFIER
VIBRATING SCREEN 35 mesh
Nonferrous metals
Nonferrous metals
Clear glass
Colored glass, mill scale
Clear glass
SAND PUMP
SAND PUMP
Sands
SAND PUMP

Physical Beneficiation Flowsheet for Concentrating Valuable Materials Contained in Incinerator Residues.

APPENDIX D

STATISTICAL DATA

TABLE D.1

STEEL SCRAP STATISTICS

	Composite Average Price Heavy Melting Steel $ per Gross Ton	Purchased Ferrous Scrap Consumption in Thousands of Net Tons*	Composite Average Price #2 Bundles $ per Gross Ton
1921	$ 12.61	9,100	$
1922	15.83	15,500	
1923	19.06	14,300	
1924	17.16	15,700	
1925	17.13	17,900	
1926	15.48	19,000	
1927	14.00	19,000	
1928	14.29	22,400	
1929	16.30	23,900	
1930	13.46	16,800	
1931	9.80	12,300	
1932	7.54	6,700	
1933	9.47	9,500	
1934	11.07	10,600	
1935	11.85	14,636	
1936	14.83	19,552	
1937	18.03	20,311	
1938	13.54	11,227	
1939	16.39	16,705	
1940	18.76	19,482	
1941	19.50	25,300	
1942	19.17	27,135	
1943	19.17	26,613	
1944	18.55	25,922	
1945	19.15	25,230	
1946	20.28	23,350	20.21
1947	36.35	29,286	36.20
1948	41.66	32,544	40.50
1949	27.56	25,172	23.51
1950	34.75	32,930	29.32
1951	43.15	37,881	42.36
1952	41.79	34,184	42.83
1953	39.52	36,439	34.41
1954	28.58	23,394	22.27
1955	40.19	35,735	31.34
1956	53.81	36,845	42.86
1957	46.75	31,086	37.63
1958	38.08	23,291	27.51
1959	40.49	29,043	27.90
1960	32.95	26,095	22.15
1961	36.28	25,305	24.72
1962	28.23	25,284	20.44
1963	27.11	29,432	19.85
1964	33.67	31,831	22.69
1965	34.35	35,804	22.83

TABLE D.1 (Cont'd)

STEEL SCRAP STATISTICS
(Continued)

	Composite Average Price Heavy Melting Steel $ per Gross Ton	Purchased Ferrous Scrap Consumption in Thousands of Net Tons*	Composite Average Price #2 Bundles $ per Gross Ton
1966	$ 30.87	36,671	$ 21.80
1967	27.62	32,654	20.42
1968	25.85	33,587	20.11
1969	30.83	36,929	24.09
1970	41.06		28.64
1971	34.09		23.55

* (to 1953, actual; 1953 and after, estimates)

Source: Institute of Scrap Iron and Steel, Inc., Wash., D.C., 1972.

TABLE D.2

ALUMINUM SCRAP STATISTICS

	Domestic Scrap Millions of pounds	Cast Aluminum Scrap Cents per pound
1942	393	8.62
1943	628	6.99
1944	651	4-04
1945	597	3.73
1946	556	5.24
1947	690	6.39
1948	574	9.44
1949	362	7.76
1950	487	10.10
1951	585	12.14
1952	609	7.53
1953	737	9.10
1954	626	10.14
1955	828	15.34
1956	856	13.99
1957	890	10.86
1958	708	9.76
1959	898	10.75
1960	876	10.25
1961	970	9.40
1962	1,164	8.70
1963	1,308	8.33
1964	1,414	10.13
1965	1,658	12.15
1966	1,775	10.30
1967	1,756	8.40
1968	1,994	8.41
1969	2,000	11.48
1970	1,900	9.79
1971	Not Available	7.00

Prior to 1942 the aluminum industry consisted of a single producer. Prices and tonnages are not readily available. The above tonnages are compiled from Bureau of Mines statistics by the Aluminum Association. Average Annual Prices are from American Metals Market.

APPENDIX E

SIGNIFICANT MARKETING RESPONSES

National Steel Corporation

GRANT BUILDING

Pittsburgh, Pa.

15219

F. E. TUCKER
Vice President Environmental Control

Please reply to
Box 431
Weirton, W. Va. 26062

Reproduced from best available copy.

March 1, 1972

Mr. Edward L. Pratt, Jr.
James Flett Organization, Inc.
51 Madison Avenue
New York, New York 10017

Dear Mr. Pratt:

I apologize for being so late in answering your letter of February 14 but as usual I have been travelling. In your letter you request an expression in writing from us that would confirm our telegram of January 31, 1972 and a confirmation of our discussions of February 8, 1972 at which time you visited our offices in Weirton, WV. For this purpose, I will repeat items 1 through 4 of my telegram of January 31.

1. Ferrous scrap material separated from incinerated municipal solid waste by the U.S. Bureau of Mines pilot plant is a usable product.

2. National Steel Corporation could accept 1,200 tons monthly of this type scrap at its Weirton, WV plant under current conditions.

3. If and when this material is available, National Steel Corporation will consider, assuming no changes in market conditions, the purchase of this material at competitive scrap prices, in accordance with its metallurgical value.

4. It is clearly understood that response to this request is not to be considered as a purchase order or as any firm commitment on the part of National Steel Corporation to make future purchases. Nor is this letter to be construed as an offer by the James Flett Organization, Inc. or its principals to sell material because the material under consideration does not currently exist.

During our discussions on February 8, we described to you all of the test work that has been done by National Steel which leads us to state that it is now possible to recycle ferrous metallics recovered either from raw refuse or incinerator residue in the basic oxygen furnace, electric steelmaking furnace or the blast furnace in limited quantities depending upon the material's physical and metallurgical specifications.

I hope this letter is suitable for your needs and look forward to pursuing this subject with you further in the future. I am also enclosing a report by E. J. Ostrowski on the recycle of incinerator residue ferrous metallics at our Great Lakes Steel plant, as you requested.

Very truly yours,

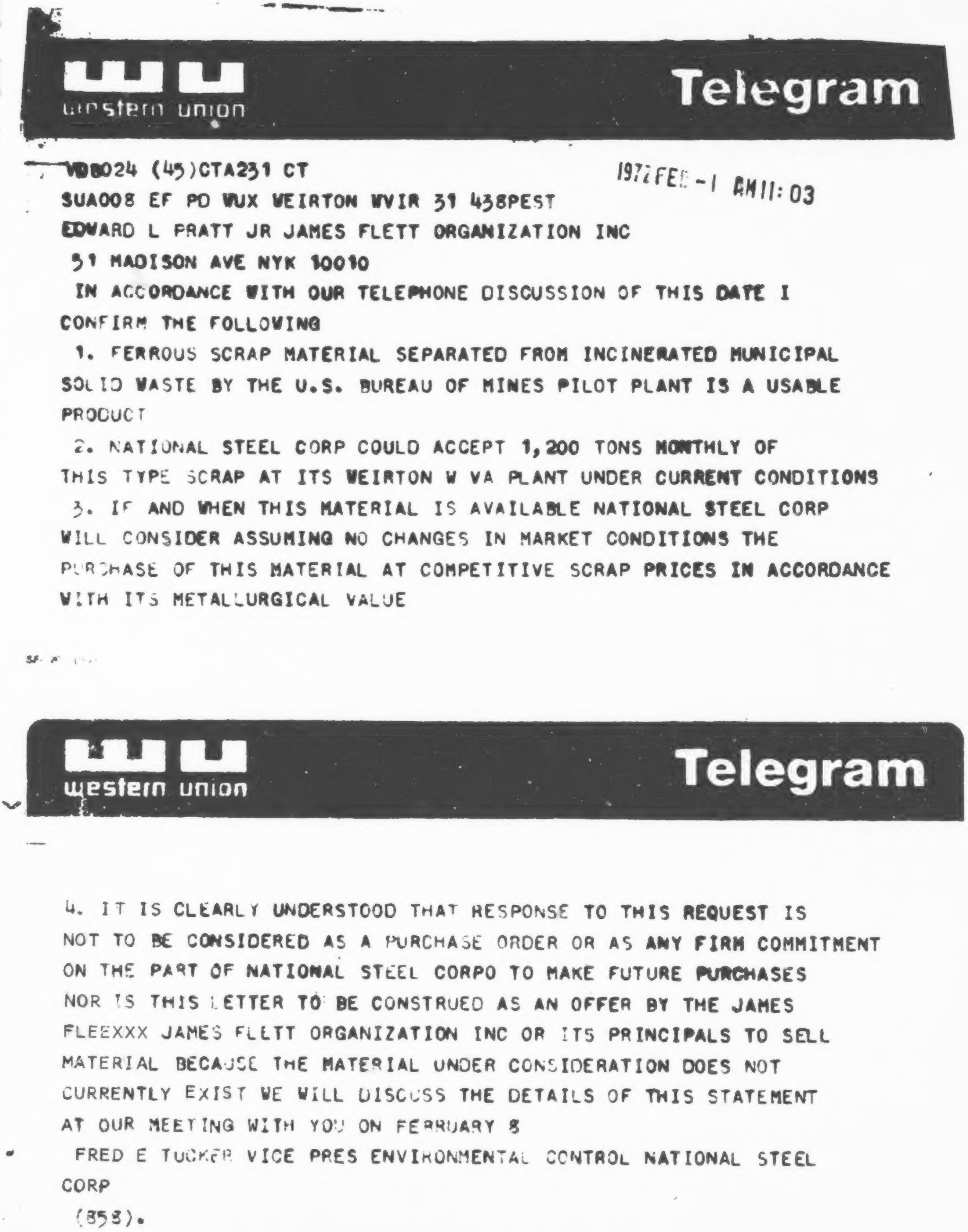
NATIONAL STEEL CORPORATION

Fred E. Tucker

Fred E. Tucker, Vice President
Environmental Control

FET 'ps
Attachment

cc: J. G. Redline
L. P. Brueckel
E. J. Ostrowski



western union Telegram

WDB024 (45)CTA231 CT 1972 FEB -1 AM 11:03
SUA008 EF PD WUX WEIRTON WVIR 31 438PEST
EDWARD L PRATT JR JAMES FLETT ORGANIZATION INC
31 MADISON AVE NYK 10010

IN ACCORDANCE WITH OUR TELEPHONE DISCUSSION OF THIS DATE I CONFIRM THE FOLLOWING

1. FERROUS SCRAP MATERIAL SEPARATED FROM INCINERATED MUNICIPAL SOLID WASTE BY THE U.S. BUREAU OF MINES PILOT PLANT IS A USABLE PRODUCT

2. NATIONAL STEEL CORP COULD ACCEPT 1,200 TONS MONTHLY OF THIS TYPE SCRAP AT ITS WEIRTON W VA PLANT UNDER CURRENT CONDITIONS

3. IF AND WHEN THIS MATERIAL IS AVAILABLE NATIONAL STEEL CORP WILL CONSIDER ASSUMING NO CHANGES IN MARKET CONDITIONS THE PURCHASE OF THIS MATERIAL AT COMPETITIVE SCRAP PRICES IN ACCORDANCE WITH ITS METALLURGICAL VALUE

western union Telegram

4. IT IS CLEARLY UNDERSTOOD THAT RESPONSE TO THIS REQUEST IS NOT TO BE CONSIDERED AS A PURCHASE ORDER OR AS ANY FIRM COMMITMENT ON THE PART OF NATIONAL STEEL CORPO TO MAKE FUTURE PURCHASES NOR IS THIS LETTER TO BE CONSTRUED AS AN OFFER BY THE JAMES FLEEXXX JAMES FLETT ORGANIZATION INC OR ITS PRINCIPALS TO SELL MATERIAL BECAUSE THE MATERIAL UNDER CONSIDERATION DOES NOT CURRENTLY EXIST WE WILL DISCUSS THE DETAILS OF THIS STATEMENT AT OUR MEETING WITH YOU ON FEBRUARY 8

FRED E TUCKER VICE PRES ENVIRONMENTAL CONTROL NATIONAL STEEL CORP

(858).

REYNOLDS ALUMINUM
REYNOLDS METALS COMPANY • RICHMOND, VIRGINIA 23218

January 27, 1972

Mr. E. L. Pratt, Jr.
James Flett Organization, Inc.
51 Madison Avenue
New York, New York 10010

Dear Mr. Pratt:

This letter is in response to your phone call requesting specifications regarding aluminum reclaimed from your proposed municipal refuse recycling plant. These are general specifications that should be compatible with a variety of aluminum processing techniques, including methods used to reclaim it from incinerator ash.

> The scrap aluminum in mixed municipal refuse must be separated from all other materials. If the material is reclaimed using dry processing following thermal treatment of the refuse, it may be baled to a minimum density of 30 lbs. per cubic foot. If the aluminum is separated from raw refuse or if wet processing techniques are used to separate the aluminum following thermal treatment of the refuse, the aluminum must be shredded or dried prior to baling. The shredded material must pass over a 12 mesh screen to reduce fines (dust, dirt, sand, paint, etc.). Fines must not exceed 3% of gross weight.
>
> If the proper separating processes are employed, we feel that the following chemical analysis might be typical of the resulting aluminum scrap:

Iron	1%
Zinc	1%
Copper	1%
Lead	0.3%
Tin	0.3%
Nickel	0.3%
Bismuth	0.3%
Chrome	0.3%
Manganese	1%
Magnesium	1%

Silicon--Variable under 5% (expected to be 0.5% or less)
Balance Aluminum

Our best estimate is that material prepared as described above and meeting chemical specifications should be worth 6 - 15¢ per pound, f.o.b. your plant in carload lots. This will be a function of preparation of material, the alloy combinations obtained and market conditions.

For your information, we have conducted experimental programs in reclaiming aluminum from non-ferrous material supplied to us by the Bureau of Mines from their College Park demonstration operation. This material consisted of two screen fractions and resulted in the following recovered alloy (processes developed by Reynolds were used in this extract):

	- 1 1/4" + 20 mesh	- 20 mesh + 40 mesh
%Si	1.5	1.0
%Fe	.9	.8
%Cu	.5	.2
%Mn	.1	.05
%Mg	<.05	<.05
%Cr	<.05	<.05
%Ni	<.05	<.05
%Zn	.3	.2
%Ti	<.05	<.05
%Pb	.1	.2
%Bi	<.05	<.05
%Sn	<.05	<.05

Thus, you see that the recovered metal from our experimental programs does fall within our general specs. However, I would caution you that our work is of laboratory scale and full-scale verification of the procedures would be required to assure yourself of resulting metal of the above composition.

I hope this information will be of use to you in your program.

Sincerely,

Robert F Testin
Robert F. Testin
Director, Environmental Planning

J.R. Elkins, Inc.
518 GARDNER AVENUE
BROOKLYN, N.Y. 11222
PHONE (212) 384-6490

January 20, 1972

James Flett Org., Inc.
51 Madison Ave.
New York, N.Y. 10010

Att: Mr. E. L. Pratt

Dear Sir:

Relative to our conversation of January 19, 1972, please be informed that we are familiar with the aluminum recovery methods of the Bureau of Mines.

We wish to state that we could purchase the recycled aluminum that we talked about at approximately two (.02) cents below the going price of cast and sheet.

This letter is not to be construed as a purchase order and is merely an approximation of the value of the recycled aluminum.

Very truly yours,

J. R. ELKINS, INC.

Joseph R Elkins - M.D

JRE:cb

Joseph R. Elkins, President

METRO CONTAINERS
Jersey City, N. J. 07303

an operation of
Kraftco Corporation

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DATE ANS'D	
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Hm	
Re	cc. [illegible] ✓

April 28, 1972

Mr. Russell Cummings
Manager Project Division
Leonard S. Wegman Company, Inc.
101 Park Avenue
New York, New York 10017

Dear Mr. Cummings:

Our Mr. Bieryla informs me that he recently discussed the feasibility of a commitment from our company for the purchase of flint cullet obtained through the Bureau of Mines System from North Hempstead incinerator residue.

Since this falls within the purview of the Purchasing Department, I am writing to confirm that we would be willing to purchase six (6) tons of this cullet per day at the price of fifteen dollars ($15.00) per ton delivered to our Jersey City plant. It must be understood that this material must meet or surpass the quality of the March sample and that if the quality is inferior to the March sample we would not be commited to purchase it.

Unfortunately, our Glass Technologist is out of the country and I am unable to list our specifications. However, when he does return he will provide these specifications under separate letter.

I would like to apologize for our tardiness in responding and should additional questions arise or should further information be required, do not hesitate to contact me.

Very truly yours,

R. J. Talbert

R. J. Talbert
Vice President,
Director of Purchases

METRO CONTAINERS
Jersey City, N. J. 07303

an operation of
Kraftco Corporation

ROUTING	
ANS REQ'D	
DATE ANS'D	
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WBR	

May 26, 1972

Mr. Russell Cummings
Manager Project Division
Leonard S. Wegman Company, Inc.
101 Park Avenue
New York, New York 10017

Dear Mr. Cummings:

On April 28 Mr. Talbert, Metro Containers' Director of Purchases, wrote to you in regard to this company accepting shipments of incinerator residue glass.

The residue glass should be as free of contamination and of the same particle size as the sample we received from the Bureau of Mines in March. We present the following specifications:

Particle size:	100% passing 20 Mesh 90% minimum cumulative on 200 Mesh
Total aluminum content as aluminum oxide:	2.25% maximum
Total iron content as ferric oxide:	0.20% maximum
Total chrome content as chromic oxide:	0.025% maximum
Total copper content as cupric oxide:	0.007% maximum
Total lead content as lead oxide:	0.05% maximum
Titanium content as titanium dioxide:	0.15% maximum
Silica:	72-73%
Sodium Oxide:	13-15%
Barium Oxide:	0-0.25%
Potassium Oxide:	0-0.5%
Calcium Oxide:	9-11%
Magnesium Oxide:	0.5 - 1.75%
Ignition Loss at 1200°F	0.20% maximum

There should be no refractory mineral particles.

Very truly yours,

METRO CONTAINERS

R.G. Dreyfuss

RGD/sm

OWENS-ILLINOIS
GENERAL OFFICES Ⓘ TOLEDO, OHIO 43601

April 20, 1972

GLASS CONTAINER DIVISION
OFFICE OF ENVIRONMENTAL AFFAIRS

Mr. Felix G. Andrews
Commissioner of Public Works
North Hempstead
1025 Northern Blvd.
Roslyn, New York 11576

Dear Mr. Andrews:

We are pleased to reply to your request for an opinion of, and the commitment for, the cullet beneficiated through the Bureau of Mines system.

Due to a mixup in the original sampling, we received only one batch of the initial material. It was composed of mixed material, including stone and a great deal of foreign matter, and of no use in the glass container manufacturing process.

A sample of incinerator residue from the Roslyn (North Hempstead), Long Island incinerator, which was submitted for analysis by Wegman Associates on March 28, was acceptable in all ways except for refractory particles. The sample was beneficiated at the Bureau of Mines facility at College Park and included some additional processing, i.e. froth flotation, etc.

Chemical analysis of the sample is as follows:

% SiO_2	72.6
% Al_2O_3	2.35
% Fe_2O_3	0.22
% Cr_2O_3	0.029
% TiO_2	0.14
% CaO	9.14
% MgO	1.59
% BaO	0.14
% Na_2O	13.6
% K_2O	0.4
% CuO	0.006
% PbO	0.044
% MnO	0.025
% Sulfide	0.005

Physical sizing of the material is as follows:

Mesh	%
+30	4.2
+40	12.1
+50	20.7
+70	19.7
+100	16.2

+140	13.6
+200	8.8
Pan	4.7

The number of corundum particles per pound of sample is as follows:

	+3.3 sp. gr. separation	+2.75 sp. gr. separation
+40 mesh	6	14
+60 mesh	41	50

The specifications for refractory particles is not more than 2 particles greater than 40 mesh in size nor 20 particles in size range -40 +60 mesh on a one pound sample.

If this material were available today and within the required refractory specification, we would be willing to purchase 6 tons per day at $12 per ton delivered. We see no reason at present to think that this offer will decrease during the time necessary to build the incinerator residue reclamation system.

Our plan would be to utilize this material experimentally in our color furnace at our North Bergen, N. J. plant for this two year test period. This experimental program would consist of introducing ever-increasing percentages of this material to our tanks beginning at the 1% level in order to establish the necessary criteria for further utilization of the larger quantities that would in all probability develop if other incinerator residue recalamation programs come on stream throughout the nation.

We suggest you also consider the utilization of the glass-rich fraction prior to any beneficiation process in glasphalt production on a county-wide basis, or for use in the manufacture of construction materials and other secondary product possibilities.

We would be completely agreeable to aid in an advisory capacity supplying all technical assistance we can, considering our limited number of personnel, when applied to the solid waste problem on a national basis.

Very truly yours,

OWENS-ILLINOIS, INC.

T. A. Jenkins

Thomas A. Jenkins, Director
Environmental Affairs

lp

cc: Mr. R. C. Donovan
Mr. B. B. Jones
Mr. J. M. Smathers
Mr. C. G. Depew
Mr. M. J. Tully
Leonard Wegman Co., Inc.

+140	13.6
+200	8.8
Pan	4.7

The number of corundum particles per pound of sample is as follows:

	+3.3 sp. gr. separation	+2.75 sp. gr. separation
+40 mesh	6	14
+60 mesh	41	50

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Mr. M. J. Tully

Leonard Wegman Co., Inc.

Thatcher
Glass Manufacturing Company
1901 GRAND CENTRAL AVENUE. ELMIRA, NEW YORK 14902

April 21, 1972

Mr. Russell Cummings
Manager, Project Development
Leonard S. Wegman Company, Inc.
101 Park Avenue
New York, NY 10017

Dear Mr. Cummings:

This is written to advise you that our company is prepared to commit to purchase up to six (6) tons per day of the clear glass fraction for a period of two years from the inception of your Bureau of Mines separation system which will include flotation, water jigging and high intensity magnetic separation at The Roslyn (North Hempstead), New York incinerator. The glass is to be used in making new glass containers on an experimental basis.

The quality of the glass cullet should be equal to or better than the recent samples submitted as defined by the attached analytical results. It is understood that if the glass is not equal to the quality of the samples, the glass would not be acceptable to us and there will be no obligation on our part to purchase the glass.

The agreed price will be $15 per ton delivered. Delivery via truckload will be accepted at our plant located at Wharton, New Jersey, Monday through Friday between the hours of 8 a.m. and 4 p.m. The trucks must be weighed prior to delivery at the shipper's expense. The certified scale weight ticket shall govern for invoicing and payment. Payment will be net 30 days.

It is further understood that in case performance of this agreement by either of the parties is prevented by strikes, fires, shortages of transportation facilities, technological changes, production curtailment, or other causes beyond control of the parties, neither party shall be liable to the other for breaches of this agreement attributable to these causes.

Very truly yours,

TJ Deegan

T. J. Deegan
Gen'l Purchasing Agent

Thatcher Glass Manufacturing Company, Elmira, New York

RESEARCH LABORATORY CHEMICAL ANALYSIS REPORT

MATERIAL Incinerator Residue
SOURCE
TANK NO. W-8678
Rec'd. DATE 4/5/72
REPORTED 4/10/72
S.A.V.

Copies:

CONSTITUENT	SYMBOL	DATE		2 SIGMA LIMITS AND AVERAGE			~~CALC'D.~~
		W-8678		Lower	Average	Upper	Owens-Illino
Silica	SiO_2	72.75					72.6
Alumina	Al_2O_3	2.11					2.35
Iron	Fe_2O_3	.175					.22
Calcia	CaO	9.18					9.94
Magnesia	MgO	1.66					1.54
Barium Oxide	BaO	.12					.14
Sodium Oxide	Na_2O	13.26					13.6
Potassium Oxide	K_2O	.53					0.4
Boric Oxide	B_2O_3						
Sulphur Trioxide	SO_3						
Fluorine	F_2						
Arsenic Pentoxide	As_2O_5						
Titania	TiO_2	.082					.14
Zirconia	ZrO_2						
	Cr_2O_3	.011					.029
	MnO	.035					.025
		99.92					
Density (As Received)							
Density (Reannealed)							

*By Atomic Absorption

REMARKS: Wegman sample (via Anchor-Hocking) cleaned incinerator residue, glass-rich.

SIEVE SPECIFICATION

TMC 22-882 R 2
3/71

ant Hempstead, N.Y. (Wegman)
Date April 10, 1972

Material Incinerator Residue
Supplier W-8678

ieve Sample No.								
Railroad								
ar. No.								
Date								
EVE NO.	SIEVE SPECS.	Percent on Sieve						
10	Max.	-						
14	Max.	-						
20	Max.	-						
28	Max.	4.3						
35	Max.	4.7						
48		29.3						
65		21.1						
100	Min.	17.2						
150		13.1						
200		6.5						
PAN	Max.	3.0						
ERCENT MOISTURE uried one hour at 190°C								
l.HCl (N) (I)/ gm								
Percent Na_2O								
ercent Al_2O_3								
ulk Density bs./cu. ft.								

EMARKS: Glass reclaimed from incinerator residue by Bureau of Mines process.

Chairman William J. Ronan
Lawrence R. Bailey
Leonard Braun
William L. Butcher
Donald H. Elliott
Justin N. Feldman
Harold L. Fisher
Mortimer J. Gleeson
Frederic B. Powers
Eben W. Pyne
William A. Shea

M

**The Long Island
Rail Road**

Jamaica Station Jamaica, New York 11435 Phone 212 JAmaica 6-0900

ROUTING
ANS. REQ'D
DATE ANS'D
RC

May 10, 1972
F-TH-252-B

Mr. Russell E. Cummings, P.E.
Manager, Project Development
Leonard S. Wegman Company, Inc.
101 Park Avenue
New York, New York 10017

Dear Mr. Cummings:

Regarding your request for multiple car rates on ferrous scrap in briquette form from Roslyn, New York to Weirton, West Virginia.

Please be advised that the Long Island Rail Road Company is willing to sponsor and support a proposal at the proper time for a rate of $12.25 per gross ton subject to the recently authorized Temporary Surcharge of 2 1/2% and subject further to any subsequent general freight rate increases that may be authorized. The minimum weight requirements will be 500 gross tons per shipment in not more than ten cars subject also to usual multiple car conditions such as to be shipped from one consignor to one consignee on one day from one location at one origin to one location at one destination.

The number of freight cars required to accommodate a minimum shipment of 500 tons but not more than 10 will be made available as a unit subject to 48 hours free time for loading commencing with the first 7 a.m. after placement. After expiration of the free time, normal demurrage charges of $10 per car per day will apply during the first four days; $20 per car per day for the next two days and $30 per car per day thereafter.

As indicated in my previous letter, any adjustment in rates for this movement would require the concurrence of our connecting carriers. We anticipate no problems in this area, however, as the suggested rate is pretty much in line with what is presently in effect for multiple car movements of scrap iron between other points involving similar distances.

Incidentally, we check the present normal single car rates to be $18.37 gross tons - 80,000 pounds and $15.41 gross tons - 112,000 pounds per Penn Central Freight Tariff 2070-B and TL/CTR Freight Tariff E-2009-H, respectively.

Very truly yours,

J. L. Faraci

J. L. Faraci
General Freight Agent

JLF/mlm

APPENDIX F

GLOSSARY OF TERMS AND ABBREVIATIONS

Acre-foot. A volume one acre in area and one foot deep.

Basic oxygen process. A steelmaking process, increasing in importance, in which pure oxygen is blown down into the furnace, speeding up the process.

Blast furnace. A process of converting iron ore to pig iron, whereby iron ore, coke and limestone are charged into a furnace; the oxygen in the air reacts with the coke, forming heat and carbon monoxide which, in turn, reduces the iron oxides to metallic iron. Impurities combine with lime formed from the limestone, and form slag, which floats on the iron.

BOP. Basic oxygen process.

Bulk refuse. Large items such as wood and metal furniture, large and moderately sized appliances, cartons, bedding, lumber, branches and so on.

Cullet. Glass scrap.

Cupola. A cylindrical shaft type of blast furnace used for remelting iron before casting.

cy, cu. yd. Cubic yard.

Demolition waste. Waste resulting from the construction, remodeling, repair and demolition of buildings. It includes earth; stone; brick; plaster; lumber; concrete; wallpaper; plumbing, heating and electrical waste; shingles and roofing.

Detinning process. A process by which the tin coating is removed from ferrous metal scrap.

Electric arc furnace. A modern steelmaking process in which the molten metal is heated by an electrode, especially applicable in smaller plants and in locations where large supplies of scrap are available.

Flint glass. Clear glass cullet.

Garbage. Animal and vegetable waste resulting from the handling, sale, preparation, cooking and serving of foods.

Garden trash. Yard trimmings, leaves, some earth, and so on. Landscaping waste may include tree branches.

Gross ton. See "Long ton".

Heat. Single melt in the steelmaking process. The time to refine one charge varies from 8 to 10 hours in the open-hearth process to one hour in the basic oxygen process.

Home scrap. Scrap which originates as a result of making steel and basic steel products such as plates, structurals, sheet, coil, bars, castings, wire and so on. Also called "revert scrap".

Incinerator bundles (ISISI specification). "Tin can scrap, compressed to charging box size and weighing not less than 75 pcf. Processed through a recognized garbage incinerator."

Long ton (gross ton). 2,240 pounds.

Metallization. The proportion of metallic iron to total iron in prereduced iron ore.

Miniplant. An electric steel plant producing 4,000 to 18,000 net tons per month from scrap and prereduced iron ore, and rolling rebars, wire rods and simple merchant products for a local market.

Net ton. See "Short ton".

Nominal capacity. The theoretical capacity for which a furnace grate is rated.

Number 2 bundles (ISISI specification). "Old black and galvanized steel sheet scrap, hydraulically compressed to charging box size and weighing not less than 75 pcf. May not include tin or lead-coated material or vitreous enameled material."

Open hearth process. A process by which a charge of scrap and molten pig iron is refined to steel. The pool of molten metal covered with slag lies on the hearth of the furnace, exposed to the sweep of flames. Oxygen from the iron oxide oxidizes the excess carbon, while the slag absorbs impurities.

Pcf. Pounds per cubic foot.

Pelletized ore. Marble-sized pellets with iron content of about 65%, made by extracting iron oxide from taconite, a widespread, low-grade ore.

Practical capacity. The actual capacity at which an incinerator plant is capable of operating.

Prereduced iron ore. Pelletized iron ore that has been further processed to concentrations of up to 95% Fe by direct reduction. Also called "metallized pellets".

Raw refuse. The refuse in the condition received at the refuse disposal plant, including paper, plastics, metal containers, vegetable matter, bulk items, construction and landscape waste.

Rubbish. Paper, cartons, boxes, wood, garden waste, appliances, wood and metal furniture, bedding, glass, crockery, and so on.

Short ton. 2,000 pounds.

TPD. Tons per day.

TPH. Tons per hour.

APPENDIX G

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